On Repairing the Cables of the Allegheny Suspension Bridge at Pittsburgh, Pa.*

BY FRANCIS COLLINGWOOD, M. INST. C.E.

The author was called upon, in August, 1883, to examine the suspension bridge across the Allegheny River at Pittsburgh, and to report upon its condition. The bridge has been in constant use since 1861, having been built by the late Mr. John A. Roebling, well known as a designer of this type of bridge. It consists of two full spans of 343 ft. 2 in. length each, and two half-spans of 179 ft. 1 in. each. The floor is about 41 ft. wide, and is supported on four cables made of iron wire of an average diameter of 0.145 in. The inner cables are 22 ft. between their centres at the lowest point, spreading to 26 ft. at the points of suspension. Each cable contains two thousand one hundred wires laid up in seven strands, and measures 7½ in. in diameter. The outer cables are 42 ft. between their centres at the lowest points, reduced to 38 ft. at the point of suspension. Each cable contains seven hundred wires laid up in two strands, and is 4½ in. in diameter. There are heavy iron parapets at the outer sides of the sidewalks, and a system of long stays to each cable, to stiffen the bridge against vertical oscillations. The serving or so-called wrapping-wire on the cables measures 0.098 in. in diameter, and is included, of course, twice in the diameter given for the cables.

The strands pass at the anchorages round cast-iron shoes, and the shoes are attached by pins to wrought-iron anchor bars. At each end of the small cables there are three, and at each end of the large cables nine, such bars. Those for the large cables are in two sets, so arranged that a rectangle surrounding the strands at the point of attachment is 22 in. square. These bars are the upper set of a series of similar ones, the lowest of which take hold of the anchor-plate, and all the bars and the strands (to the clamp to be mentioned) were buried in the masonry of the anchorage.

From the shoes the strands converge for about 12 ft., at which point they are brought to a round form and held in close contact by a heavy iron clamp From thence they are wrapped throughout, except where they pass over the saddles at the towers. Between the shoes and the clamp the wires in each strand are brought compactly together by a seizing of several turns of annealed wire at intervals of about every 7 in. As originally finished, this unwrapped part of the cable was enclosed in heavy cotton duck, and all interior spaces were filled in solid with hot coal-tar, which had been boiled and treated with quick-lime to neutralize any acid it might contain.

As an additional precaution, that portion from the clamp 3 ft. back into the masonry was surrounded by ¼ inch boiler plate tightly clamped on, and coal-tar pitch was poured around the outer end. The whole cable for 12 ft. back, including the shoes, was then enclosed in brickwork and cement; 6-in. flags were laid in cement over the brickwork, and finally a second set of flags above these, to form the sidewalk. Over the side cables, the foundations of the tool-houses took the place of the sidewalks.

Examinations had been repeatedly made at the points where the cables emerged from the masonry to see that the coverings were intact, but no more extended examination had been deemed necessary. The author felt, however, that the responsibility was too grave to allow him to assume that all was sound simply because the exterior appeared so. The sidewalk and flagging were therefore removed from over one end of a large cable, and on cutting through the canvass it was found that the tar had partially disappeared, and that the cavity was nearly full of a dirty, greyish liquid. There was also extensive rusting of the wires, so that the seizing-wires, 0.06 in. in diameter, were in many places rusted through, and the cable-wires deeply pitted. A second cable-end was opened with similar results. A general survey of the bridge was then made, revealing fine cracks in the paint on the cables which admitted moisture, grave defects in the masonry, particularly of one of the piers, and a number of other minor flaws.

A full statement of the facts was thereupon made to the directors, with the recommendation that every cable should be examined throughout and repairs made immediately; also that the cables and other ironwork should be scraped and repainted, all defective stones in the piers replaced by sound ones, the masonry re-pointed, and that the wrought-iron protecting-plates to the pier nosings should be repaired, etc.

Authority was given to the author to proceed with the work at once. As parts of it were entirely novel, it required close personal attention throughout. The first step was to determine how far the damage to the cables extended. One of the openings already made was therefore enlarged, and the boiler-plate and wrapping removed so as to expose the strands back to and around the shoes. It was found that the rust extended outside of the anchorage, and under the wrapping. It was then decided to remove every seizing, to cut a slit about 45 ft. in the bridge floor to where the cable emerged above it, and to remove the clamp and also the wrappings so far as might be necessary to discover the full extent of the damage. Accordingly, about 10 ft. length of cable was unwrapped, leaving the wires exposed and entirely free for about 22 ft. of their length.

On examination the serious damage to the wires was found to extend about 3 ft. from the anchorage outward. Beyond this there was a little dry rust, but no pitting; and still farther from the anchorage the paint on the interior wires was yet gummy.

The rust seemed to be of two kinds. First, a red oxide, where the wire appeared to have been attacked as if by acid, the so-called fibre being exposed. In some such cases the rust had eaten through the exterior in a narrow slit, and had then attacked the interior, leaving a shell only. The second form of rusting was by the formation of a hard blackish substance containing much sulphur, which, when scaled off, left a deep pit, as if gouged out by a chisel.

In one cable end eight wires had been eaten entirely through, and one wire or more in each of the others. Referring to the composition of the rust and liquid found among the strands, the following letter to the author is pertinent. The writer, Professor Otto Wuth, is a practical chemist residing in Pittsburgh, and has been engaged in the manufacture of the various products resulting from the distillation of coal-tar.

PITTSBURGH, Aug. 18th, 1883.

"I have carefully examined the specimens of scales you took from the wires of the cables of the suspension bridge, and found them to be a combination of the hydrated peroxide of iron and sulphate of iron. The liquid consisted of a weak solution of carbonate and sulphate of ammonia, colored by tarry matter, and is almost identical with tar-water from the gasworks. The cables, as you stated, were first coated with boiled linseed oil and afterwards with coal-tar. The tar had evidently not been heated long enough and high enough to drive off all the water and the salts of ammonia contained in all coal-tar at the rate of 5 to 7 per cent.

"The reaction of coal-tar is always alkaline—*very* alkaline—never acid. The reaction of the acids contained, such as carbolic and cresylic, is also alkaline; they do not act like the mineral acids on iron. By heating coal-tar with caustic lime you only convert the carbonate of ammonia into caustic ammonia. Now the action of the coal-tar upon the wires has undoubtedly been this:

"The oils contained in the tar first dissolved the coat of linseed oil; then the sulphuret of ammonia, which is contained in the tar in considerable quantity, acted upon the surface of the iron, converting it into the sulphuret of iron, which again was converted into the sulphuret by the oxygen of the air, which could not have been completely excluded. This alternate action of the sulphuret of ammonia and air was continued until the sulphuret was entirely exhausted. The oxidation was further carried on by the atmospheric air in the presence of water and carbonate of ammonia."

How the water came to be where found it is not easy to say. The upper surface of the strands was but 18 in. below the surface of the side-walk, and exposed to considerable alternations of heat and cold. A cavity was evidently formed by the tar gradually oozing into the surrounding brickwork when exposed to the heat of hot summer days. Air would then slowly percolate to and fro as the masonry changed in temperature, and moisture would probably be condensed, and the water slowly collected. It is possible that part of the sulphur and ammonia accumulated in this way, as they must be constantly present more or less in the atmosphere of such a smoky city as Pittsburgh.

It was evident that the only course to pursue was to cleanse the wires thoroughly. This was at first attempted by the use of solvents such as benzole, kerosene, etc.; but it was impossible to cleanse the interior strands in this way even by drenching them. Scraping each individual wire was then reluctantly resorted to. After trying various scrapers, none of which worked satisfactorily, one was adopted which proved cheap and effective. A ⅜ in. steel rod had one end flattened and turned up for about ½ in., so as to make with the rod an angle of about 80°. A semicircular notch, of about the same diameter as the wire, was then filed in the end, and the edge made sharp, hardened, and tempered. With these, four men could clean about one hundred and seventy-five wires in ten hours. To get at the interior strands, wedges were used to force them apart. Whenever a damaged wire was found it was marked by a bit of wire twisted on. All such wires were examined, and if the loss of strength was 10 per cent. or more, it was repaired, otherwise it was passed. It was soon found that the damage was almost entirely confined to the outer two layers of wires in each strand. The seizings around the strands had held the wires so closely in contact that the destructive agent had not penetrated farther.

While this preliminary work was going on, experiments were made to determine the best method of repairing the damaged wires. The only previous work of this kind, so far as known, was that done at Niagara Falls;[1] where, in making the final splice, the two parts of a wire were kept under strain by a bar having a lever pivoted across each end. The shorter arms of these levers were provided with clamps and thumb-screws for taking hold of the ends of the wire to be joined, and gave a lever-arm of 2 in. The other arms were 10 in. long. The short lever-ends having been clamped to the extremities of the cable-wire, one of the long arms was fastened by a wire to some fixed object; to the second long arm a spring balance was attached, and to this a pair of small pulleys and tackle, leading finally to some other fixed object. By this means a definite pull on the balance could be transmitted to the two branches of the cable-wire, since the separation of the long arms would draw the short ones towards each other.

The difficulties with this apparatus were, first, that it was not self-contained; secondly, the range of motion, being small, it required exact fixing on the wires to ensure the ends being in line when the strain was on; thirdly, the room was insufficient for wrapping the splice.

The author devised an apparatus as follows:

* From other Selected Papers of the Institution of Civil Engineers.

[1] Minutes of Proceedings Inst. C. E., vol. lxv., p. 389.

a stiff square bar 2 ft. 6 in. long had its sides finished smooth, one end was flattened, and to this end a stiff cross-head about 7 in. long was firmly riveted. One end of the cross-head was provided with a clamp and thumb-screw for holding the wire to be spliced. The other end of the cross-bar had a notch for receiving the ring of a heavy spring-balance. A second cross-bar about 11 in. long was fitted with a long socket near its center, so as to slide freely on the long bar. One end of the sliding-bar had also a clamp and thumb-screw for holding the opposite end of the wire to be spliced. Through the remaining end of the sliding-bar was a hole parallel to the main bar of the machine, through which an eye-bolt passed freely. The eye-bolt had a long thread cut upon it, and carried a hand-wheel with a corresponding internal thread. The hook of the balance passed through the eye of the bolt.

This machine gave plenty of movement for extending the balance, and taking up the slack of the wire, and was very convenient in all contracted places.

According to Mr. Roebling's original notes, an abstract only of which was available, the maximum working strain per wire is 267 lbs., of which 109 lbs. or 41 per cent., is live load, and 158 lbs. or 59 per cent., is dead load. A piece of wire said to be from the original bridge wire was tested with the undermentioned results:—The stretch in this and the following tests was taken on 1 ft. of length by a finely divided vernier gauge, having a multiplying lever, and a second vernier for the finer readings.

Diameter of specimen, 0.144 in.; area, 0.016286 sq. in. The readings were uncertain up to 200 lbs. strain, owing to inaccuracy in the adjustment of the gauge.

Strain.	Gauge reading.	Difference.
Lbs.	Foot.	Foot.
200	1.00017	0.00023
300	1.00040	0.00024
400	1.00064	0.00023
500	1.00087	0.00022
600	1.00109	0.00022
700	1.00131	0.00020
800	1.00151	0.00033
900	1.00184	

At 1,260 lbs. the wire broke with a measured set of 0.013 ft. Diameter at point of rupture, 0.110 in.; strength per sq. in. of full section, 77,365 lbs.

A new splice in a wire when tested gave under a strain of 300 lbs., an addition of 0.018 in. in length by slip and stretch. Now in splicing in a new piece of wire, the final splice must evidently be made under an excess of strain sufficient to compensate for three things; first, for the probable slip in the splice in taking up a working strain; secondly, for the stretch that will occur in the part (about 2 ft. long) contained in the machine while splicing, when it comes under strain; and thirdly, for the extra strain induced by pulling the wire out from a straight line while splicing.

To determine this excess of strain the following calculations were made:—

	Inch.
The slip at the splice is, say	0.0180
Taking 200 lbs. as the average strain in a wire with the bridge in use, and 0.00023 ft. as the stretch per 100 lbs., the 2 ft. length of wire in the machine will stretch $0.00023 \text{ ft.} \times \frac{200}{100} \times 2 \text{ ft.} \times 12 =$	0.0110
Suppose the wire in splicing to be drawn 4 in. from a straight line at the center of 20 ft. in length, the additional length required is =	0.1332
Total excess of length requisite in making the splice =	0.1622

On the supposition that the wrapping around the cables is tight enough to oblige the first 10 ft. length under the wrapping to take up the extra strain, and inasmuch as the wires pass around the shoes and have therefore a double length, the strain would act on about $(12' + 10' \times 2)$; or say 60 ft. length of wire. According to the previous test, to stretch 60 ft. of wire 0.1622 in. a strain would be required equal to

$$\frac{0.1622 \text{ in.}}{12} \div \frac{0.00023 \text{ ft.} \times 60 \text{ ft.}}{100} = 98 \text{ lbs.}$$

This would give the strain on the balance as 200 + 98, or, say, 300 lbs.

A balance with 400 lbs. capacity was therefore provided, but on trial it was found that a pull of about 500 lbs. was necessary to ensure a full strain in the wire after completion of the splice. The reasons for this seemed to be, first, that the stretch did not probably reach so far as 10 ft. under the wrapping; secondly, the friction in passing around the shoe had not been taken into account; thirdly, the wires were frequently partially bound by other wires, and the final splice was nearer one end of the free wire than 10 ft.

Another element of uncertainty was the constantly varying load, as the traffic on the bridge is very heavy and subject to rapid and extreme fluctuations. Still another practical difficulty was the fact that from loosening the strands and removing the clamps and wrappings, the angle made by the unwrapped strand, with the round cable was removed 10 ft. farther from the shoes and several cable-wires were no longer equally strained.

For these various reasons it became necessary to assume limits of strain, within which differences would be allowed. As the limit of elasticity of the wire was from 800 to 1,000 lbs., and the extreme working-strain 267 lbs., it was evident that if the minimum strain per wire was sufficient, the maximum might be largely increased without danger of rupture or inharmonious working. Furthermore, any excess in pull in the sound new wires would tend to relieve the slightly damaged wires which were not to be repaired. This reasoning of course would not apply if carried too far, since an excess of strain introduced into a large number of wires of a considerable length would have changed the curve assumed by the cable.

The minimum fixed upon was 200 lbs. per wire, and was ensured in the following manner. Each wire as spliced was marked by a tag, and once a day all the wires were tested, by applying a spring-balance at the center of their free length, and pulling them out 2 in. from a straight line. Suppose the balance to then mark 8 lbs., by the parallelogram of forces the proportion

$$\frac{4}{12} \text{ in.} : 10 \text{ ft.} = 8 \text{ lbs.} : 240 \text{ lbs.} = \text{strain of wire.}$$

This simple test saved all necessity for immediate inspection of each splice.

Two men could repair from eight to ten wires daily, making two splices in each. They soon found that they were able to dispense with the weighing apparatus, and to judge the tension closely enough by feeling.

A simpler tool was then constructed for holding the wire while splicing. It was made of two bars or legs hinged together, and each bent so as to assume a form much like a pair of pen-dividers when they are opened wide, and the pen and point are in position for use. A tightening-rod, with a head at one end and a thumb-screw on the other, passed through the legs at the knuckles. The lower end of each leg was grooved across on one side; and a wedge-key fitted for clamping an end of the wire to be spliced. Most of the splicing was done with this tool; but the one with the balance was best where the space was contracted.

The total number of wires spliced was four hundred and eighty-four, of which one hundred and seventy-five were in one cable end and one hundred and seven in another. Care was taken to distribute the splices lengthwise, so as not to interfere with the smooth wrapping of the cable. The splices were made by filing the end of the wire to a flat sloping face of 3 in. length, and so as to reduce the wire at the extremity to about one-third its diameter. The wire was then laid face downwards on an iron anvil, and the convex side nicked for 3½ in. with a tool, having spaces of 0.033 in. to correspond with the diameter of the splicing wire.

After preparing the two ends, they were placed in the machine, the proper strain was applied, and the flat surfaces were brought in contact and tightly clamped by a hand-vice on each side of the center of the splice.

The splicing-wire was next tightly wrapped by hand; beginning at the middle of both splice and wrapping wire, and wrapping up to one of the hand-vices, then removing this vice to a second and third hold and each time wrapping up to it. The final finish of this end was given by wrapping ¾ in. beyond the filed portion of the wire, and fastening the splicing-wire by passing it twice under its own coils. The opposite half splice was finished in the same manner.

The integrity of the splice depends upon the care taken in adjusting the parts accurately to each other, and keeping a constant strain on the splicing-wire.

Comparative tests were made of a piece of wire from one of the cables, and of a new splice in the same, and the results are given below.

Diameter of wire = 0.144 in., area = 0.16286 sq. in. The whole wire behaved as follows:

Strain.	Gauge-reading.	Difference
Lbs.	Foot.	Foot.
200	1.000050	0.000240
300	1.000290	0.000245
400	1.000535	0.000210
500	1.000785	0.000250
600	1.000195	0.000270
700	1.001265	0.000275
800	1.001540	

At 2.450 lbs. the wire broke with a set of 0.0208 foot on 1 foot. The reduction of area at the point of rupture was 51 per cent. The strength per sq. in. was 89.015 lbs.

The splice from the same piece of wire gave results as follows:

Strain.	Gauge-reading.	Difference.
Lbs.	Foot.	Foot.
100	1.000390	0.000225
200	1.000615	0.000655
300	1.001280	0.000505
400	1.001785	0.000550
500	1.002335	0.000405
600	1.002740	0.000450
700	1.003190	0.000285
800	1.003475	0.000180
900	1.003655	

At 1,350 lbs. the spliced wire broke with a set of 0.0243 ft. on 1 ft. The rupture occurred in one wire at 2½ in. from the end, or 1 in. from the centre of the splice, and with a large local reduction in area. In making the test the coils of wrapping-wire were left slightly loose at the ends to represent a probable case in actual work.

In comparison with the uncut wire, the splice shows a strength of 93 per cent. Since the splice at one end of each piece of new wire introduced has been subjected to a strain far above the working-strain, and the final splice had resisted a pull of at least 200 lbs., it is evident that the greatest possible additional slip would be that arising from the slip at the final splice, due to the difference between a strain of 200 lbs. and a maximum strain of 267 lbs. As this amount, which is very small, must be distributed over about 60 ft. length of wire it may be neglected.

A piece of new Bessemer-steel wire was tested with the following results.

Diameter of wire = 0.147 in. area, = 0.01697 square inch.

Strain.	Gauge-reading.	Difference.
Lbs.	Foot.	Foot.
300	1.000725	0.000200
400	1.000925	0.000230
500	1.001155	0.000345
600	1.001500	0.000125
700	1.001625	0.000230
800	1.001855	0.000280
900	1.002135	0.000270
1,000	1.002405	0.000335
1,100	1.003740	0.000405
1,200	1.003145	

At 1,550 lbs. the Bessemer-steel wire broke with a set of 0.0243 ft. on 1 ft. The reduction of area at the point of rupture was 47½ per cent. The strength per sq. in. was 90,442 lbs.

The tensile strength of similar sized iron-wire is given by the Trenton Iron Co. at 91,278 lbs. per sq. in.

Considering that the old wire was more or less damaged by rust, its uniformity of stretch, large reduction, and close approximation in strength, shows it to be entirely unchanged by use.

All the wires in a cable having been repaired the first step towards closing it up was to jar it thoroughly with mallets, and to get out all loose rust and dirt, after which it was thoroughly saturated with raw linseed oil. To reach the interior wires with the oil, a chisel bar had to be forced through in every direction until no uncoated wire could be found. Two days afterward a coating of boiled linseed oil was applied, and then the seizings were replaced on the part of the strands not to be wrapped. The most serviceable tool for compacting the wires of a strand to a round form, prior to replacing the seizings, was one devised for the occasion. It consisted of two semicircular pieces of iron hinged together at one end of each, and with the free ends bent radially outward. One of the free ends was left longer than the other, and had a hole slotted radially in it, to allow play for the passage of the screw. The other free end was tapped for the screw. The screw had a thread about 4 in. long, and a stem about 1 ft. long terminating in a T for convenience in turning. A collar between the screw and stem gave a bearing against the slotted end of the clamp. The interior strands which were hard to get at were compacted with this clamp with facility.

The work of bringing the strands together again to the round form of the cable, just within the anchorage, was .troublesome but not new. The wrapping of that portion outside the anchorage was at first accomplished with the special wrapping-machines used when the bridge was built. As it was impossible to employ these at all points, the ordinary serving mallet familiar to sailors was afterwards adopted, as with care it was found that good work could be effected.

The cable was saturated with white lead and oil in advance of the wrapping. Several coats of the same composition were afterwards applied over the wrapping and strands. Wherever direct vision could not be obtained, the aid of a mirror was found necessary to ensure a perfect covering.

As it would afterwards have been difficult to paint thoroughly that portion of the strands near to where they converge to a round form, it was considered best to protect them by filling for a space of 2 ft. back from the clamp with paraffine. To do this a dam of putty was made across the cable, and the 2 ft. length was surrounded by canvas, into which melted paraffine was poured until when cold the canvas would hold no more. Changes of temperature have thus far had no effect upon the paraffine as a protection.

Experience demonstrated the imperative necessity of having all parts of the cable accessible for examination, it was decided to leave tunnel-openings around the strands in the anchorages. The bottom of each opening in the masonry was therefore cut so as to drain to an opening in the front wall. The sides were removed to about 6 ft. by 16 ft. and lined with 13 in. brick walls laid in cement-mortar, the cable passing freely through the front wall, with space all around for painting. A jacket was afterwards put on each cable to keep out moisture as far as practicable.

As the head-room was insufficient for brick arches, the side walls were capped by an iron box-frame, which was covered by a series of cast-iron plates grated on the upper surface, which surface was at the side-walk grade. The plates were locked together and cemented, to prevent water from dropping on the cables; and the last plate of the series was provided with lifting rings.

In the alternation of mild and extreme cold weather, water of condensation was found to drip from the plates; to prevent this a light wooden frame has been covered with well-painted canvas and placed in the tunnel in an inclined position over the cable. Cork paint may be hereafter applied to the interior of the tunnels.

The only other point of interest was the method pursued in removing the old paint from the cables preparatory to repainting. The necessity of this was made apparent by the cracks retaining moisture after every shower; as it was reasoned that fresh paint would soon crack in the same lines, and but temporarily cure the evil. Ordinary scrapers were first tried, but were ineffective on account of the gumminess of the paint. This led to the use of cutting-tools such as chisels and drawing-knives, by which to slice it off. By keeping these sharp, the work was fully trebled in quantity over that at first attainable. The average length of large cable cleansed by one man in a day was about 25 ft.

The Both Dredging Bucket.

The successful work done with this bucket in hard material, dredged from Potomac Flats, Washington, D. C., and the general satisfaction which it has given, make an illustation of it appear desirable and acceptable.

A few remarks regarding the peculiar movements of the shells and some other new features may not be out of place.

The shells of this bucket are connected to the frame by two sets of oscillating eye-bars. One set A A, pivoted in the frame above and either side of the main shaft, leads down in a vertical direction to the hinges near the center of the shells. The other set B B, is pivoted in the frame directly under the main shaft and connects near the periphery of the shells, with the outer hinges, to which are also connected the closing arms, leading up to the sliding shaft. To show the relative positions of the shells during the opening or closing, the arcs on which the hinges of the shells move, are shown in heavy lines. The travel of the sliding shaft has been equally divided and numbered from 0 to 8, and the corresponding positions of the shells, respectively those of their hinges are marked and numbered similarly.

The shells when wide open, are shown in dotted lines. If we now follow the movements of the shells during their closing it will be seen that the outer hinges follow the arcs described by the eye-bars B B, in nearly vertical direction, while the inner hinges follow the arcs described by the eye-bars A A, in nearly horizontal direction.

The motion of the shells, following the combined movements of the two sets of eye-bars, is exactly like the motion of a shovel in the hands of a person digging in hard material; that is, while he pushes the shovel into the material, he, at the same time, depresses the handle more or less, according to the resistance met with, and succeeds in cutting a long flat slice with comparatively little exertion.

To imitate this natural movement in a simple and practical manner has been the principal and most difficult aim in the construction of this bucket, and it has been fully realized.

Owing to the nearly vertical motion of the outer hinges, the angle included by, or the spread of the closing arms, practically remains the same at all times, the result of which is the invaluable feature, not found in any existing bucket, namely, that the power transferred by the closing arms to the cutting edge of the shells is practically constant for the entire length of the cut, which fact is plainly shown by the nearly equidistant points 0 to 8 in the cutting line of the shells, which corresponds with those of the sliding shaft.

If we next examine the flat elliptical shape of the cut, as resulting from the peculiar movement of the shells, it is evident, and stands confirmed by actual results, that such a long flat slice can be cut out of hard material with less resistance and power, than the deep circular slice, which all other clam-shell buckets are supposed to cut, but never can accomplish in hard bottom.

Another very important advantage, resulting from the peculiar movement of the shells, is the fact, that, even if the shells do not sink into the bottom at all before they commence to close, the slice cut out contains enough material to entirely fill the shells. No other clam-shell buckets, even if they had the power, can do this, but in order to better fill these buckets, it is common practice to let them go down *"by the run"* and thus drive them into the bottom. Very little material may thus be gained at each dip, but certainly at high cost, considering the immense wear and tear resulting from this smashing practice. This bucket to the contrary, is rapidly but gently lowered to the bottom, and there, without sinking into the bottom, it can and will fill itself, if such is at all possible. In every instance, the bucket used on Potomac Flats Improvement, brought up a full load and often more. In closing at the bottom, the poles attached to the bucket would remain perfectly stationary and not lift at all, showing that the bucket made the full cut, as shown in the illustration; the poles would even follow down the motion of the shells, which are so guided during the first half of the cut, as to *draw into* the material.

With its sufficient and constant power, and owing to the very gradual penetration of the shells, this bucket will cut with ease, during the first half of the cut, through hard material, and being thus firmly anchored and weighed down by the material already in the shells, the pull on the hoisting chain can be constantly increased, with every inch of additional penetration and thus overcome the greater resistance without the bucket being pulled out of its prescribed cut. The last half of the cut is practically level, and here the shells cut tangent, disturbing the material not at all during cutting, and thus allthe power is utilizeb for cutting the material.

Every chance to guard against the enormous wear, which dredging buckets are subjected to, has been taken advantage of. Most prominent among these, stands the self lubricating sleeve, covering the main shaft for its entire length. This sleeve, as shown in the illustration, is cored out in the center so as to contain several gallons of oil for lubrication. Stuffing boxes at each end make it oil and water tight, and all wear at this most troublesome point is entirely prevented, besides reducing the enormous friction to a minimum. This sleeve is made of the best gun iron, and on either side of the large chain wheel, which is keyed on in the middle, the two heavy flat linked steel chains wind up. These latter are fastened to the sleeve by *one* steel rod, which passes through the central body of the sleeve and through heavy rims outside of the chains. By driving this rod either way, far enough to clear, one or both chains may be quickly taken out if necessary. The sides of the bucket frame, which also form the guides for the sliding shaft, and extend from top of frame to the main shaft (which latter passes through them), are made of the best hammered iron. The lower ends are made wider and two steel plates securely bolted to them on both sides, and properly stay bolted, form strong and immovable guides for the arms or eye-bars on which the shells are hung. The main shaft being firmly keyed into the sides of the frame, forms a strong connection between them, can-

not wear and will keep the frames and consequently all the pivots rigidly in their proper position, thus preventing undue strains and breaks in any of the parts.

The eye-bars, closing arms, in fact all parts where friction takes place, are bushed with steel or phosphor-bronze, and if worn, are quickly replaced at small cost. The whole make-up of these buckets is a new departure in mechanism, material and workmanship and is calculated to reduce costs of repairs to a minimum and increase the work to a possible maximum in hard materials.

To sum up the advantages this bucket possesses and which cannot be found in any other, we have:

1. Equal closing power during the entire cut.
2. Wide opening of shells (12 ft. for 3 yd. bucket) with a clear cut from beginning to end, and no scraping or compressing the material.
3. Entire prevention of wear of main shaft or chain-wheel, both being constantly lubricated.
4. Will cut a slice sufficient to fill the shells, without being driven into the bottom.
5. Perfect prevention of any suction.
6. Great rigidity of the shells, when working; they cannot twist out of shape by grasping a rock, log, etc., in one side of them.
7. It will give satisfaction where other first class buckets fail to do so.

As an interesting addenda to the above we publish the following remarks upon the cost etc., of the elevator, *vs.* the clam-shell dredge, and a comparison between work done by an English elevator dredge, and that actually accomplished by a Both clam-shell, in Portland Harbor, Me.:

The question is often asked, why Elevator Dredges are not employed more frequently in America, as they are believed to do very much more work at very much less expense.

To answer this question, let us refer to the article—Dredgers and Dredging on the Tees, ENGINEERING NEWS, Page 158, Vol. XI.

Let us take Dredge No. 4, which, according to its record, must be assumed as the best dredge of the three.

The cost of this dredge, without scows or towboat is $86,700.

Amount dredged in 1 year:

$$= \left(\frac{1{,}394{,}712 \text{ cbc. yds.}}{3}\right) = 464{,}904, \text{ cbc. yds.}$$

Presuming the dredge at work 275 days* only in each year, we have the amount per day = 1,690 cbc. yds.

The cost of dredging, labor and maintenance for 3 years is given at $97,865, from which follows, that the expenses for each working day:

$$= \frac{97{,}865}{3 \times 275} \text{ or about } \$118.$$

in which the repair item of $5,815 per year is included.

The actual cost of dredging, therefore would be very nearly 7 cents per cub. yd. This compared with prices paid for dredging similar material here, is certainly low, but it represents the actual cost of dredging only, while the prices for dredging in the U. S. include very handsome and often quite enormous profits for the contractors, by whom nearly all the dredging is done for the Government, as well as for other large corporations. By reason now of this contract system, it is difficult to get at the actual facts, bearing upon the cost, labor and maintenance, (each party keeping those data well out of sight) but the following estimate can be considered as approximating very close to these expenses.:

* As the article does not state the number of working days required for the given amounts of dredging, but states, that on an average 8 scow loads of 200 cu. yds. each—or 1600 cu. yds. were sent to the dumping ground daily—the number of working days assumed above, viz.: 275 must be very nearly correct.)

Cost of a—A1 Clam-shell Dredge (medium size)	$27,000
" " 2—Scows, 250 cu. yd. capacity, each $5,000	10,000
" " 1—Tow Boat	8,000
Total cost of complete plant	$45,000

This is about one-half of the cost of Dredge No. 4 scow and tow boat not included.

From the description of the material excavated by Dredge No. 4, that dredged in Portland Harbor, Me., appears to be very much the same and therefore the work done there is selected for comparison.

Amount dredged in 359 working days = 509,421 cub. yds.
Or a daily average of = 1,419 cub. yds.

The maximum often reached 2200 cu. yds. per day, and the minimum 212 cu. yds. per day in very hard quicksand.

As the dredgers had to wait considerably for scows, only about 10 hours dredging was done each day, whereas the time given for the elevator dredges would average certainly 11 to 12 hours per day.

The cost of labor and maintenance, including towing, liberally estimated, is as follows:

CREW ON DREDGE

Captain	$150 per month	
Engineer	75 " "	
Mate	35 " "	
Cook	40 " "	
Watchman	30 " "	
4 deckhands	120 " "	
		$450.00

TOW BOAT CREW

Captain	$ 75 per month	
Mate	30 " "	
Cook	35 " "	
1 Scowman	30	
		$170.00

MESS.

13 Men at $15 per month	$195.00

COAL.

Dredge, 50 Tons per month at $5.00	$225.00
Oil and waste	30.00
Towboat, 30 Tons at $5.00	150.00
Oil and waste	10.00
	$1,255.00
Contingencies	145.00
Total actual expenses per month	$1,400.00

The cost for repairs on a well managed clam-shell dredge is notoriously small, and it is believed that 8 per cent. of the value of the plant is sufficient; this would increase the monthly expense account to $1700. Allowing 26 working days per month—the daily expense is about $6500 as compared with $118 for Dredge No. 4, and the actual cost of dredging is $4\frac{38}{100}$ cents per cu. yds.

Adding 20 per cent. for interest on cost, depreciation and insurance the actual daily expense will be $93, and the cost for dredging and dumping about $6\frac{1}{2}$ cents per cu. yd., as against 7 cents for the elevator dredge.

These figures, at all events will show, that a good clam-shell dredge, in medium bottom, can successfully compete with an elevator dredge in most cases; but in view of the difference in first cost, in maintainance and repairs and adaptability, the clam-shell dredge is very much to be preferred. In dredging canals, or at localities where the excavated material can be deposited upon the banks, within short distances, either by chutes or through pipes, the elevator dredge is unquestionably to be preferred and more economical, but in most cases, dredging is done too far from shore to make the self depositing principle of the later styles of dredgers available or practical. As the dredged material, in very many instances, has to be deposited from two to twenty-five miles away from the work, the venerable mud scow will remain, for the present at least, a faithful attendant to most of the dredgers, be they elevators, scoops or clam-shells.

When we consider that in the U. S. most of the River and Harbor Improvements depend upon yearly appropriations, that very seldom large improvements are begun and continued until completed, but are cut up and continued from year to year under contract with the lowest bidder, it follows, that the American dredging contractors must have machinery, which is adapted to work in the most varying localities, and in *all* kinds of material. The variety of work which can be done with a good clam-shell dredge is very great, and in most cases, the use of an elevator dredge would be out of question, not only for practical reasons, but also on account of their enormous cost. Furthermore, as the jobs here are numerous, but generally small, it is more profitable for contractors to have a greater number of dredgers at the least original cost.

It has been shown above, that the cost of *two* good clam-shell dredgers, complete with two scows and one tow boat each, is very nearly the same as that of *one* elevator dredge without scows or two boats, and it stands to reason, that two clam-shell machines will not only excavate more material than one elevator dredge, but that they can be used on two different works at the same time, which is of great importance, when many small jobs have to be done simultaneously, under contract to be completed perhaps at about the same time.

It is well known that the dredging capabilities of the existing clam-shell buckets in different materials are very variable, certainly more so than those of the elevator dredges; a clam-shell bucket which in soft mud, will dredge 3,000 to 4,000 cu. yds. per day, will often dredge not over 200 to 300 cu. yds., in very hard sands, clay or rocks. The consequence is, that the prices for dredging vary in about the same ratio, from 10 cents to $2, and more per cu. yd.

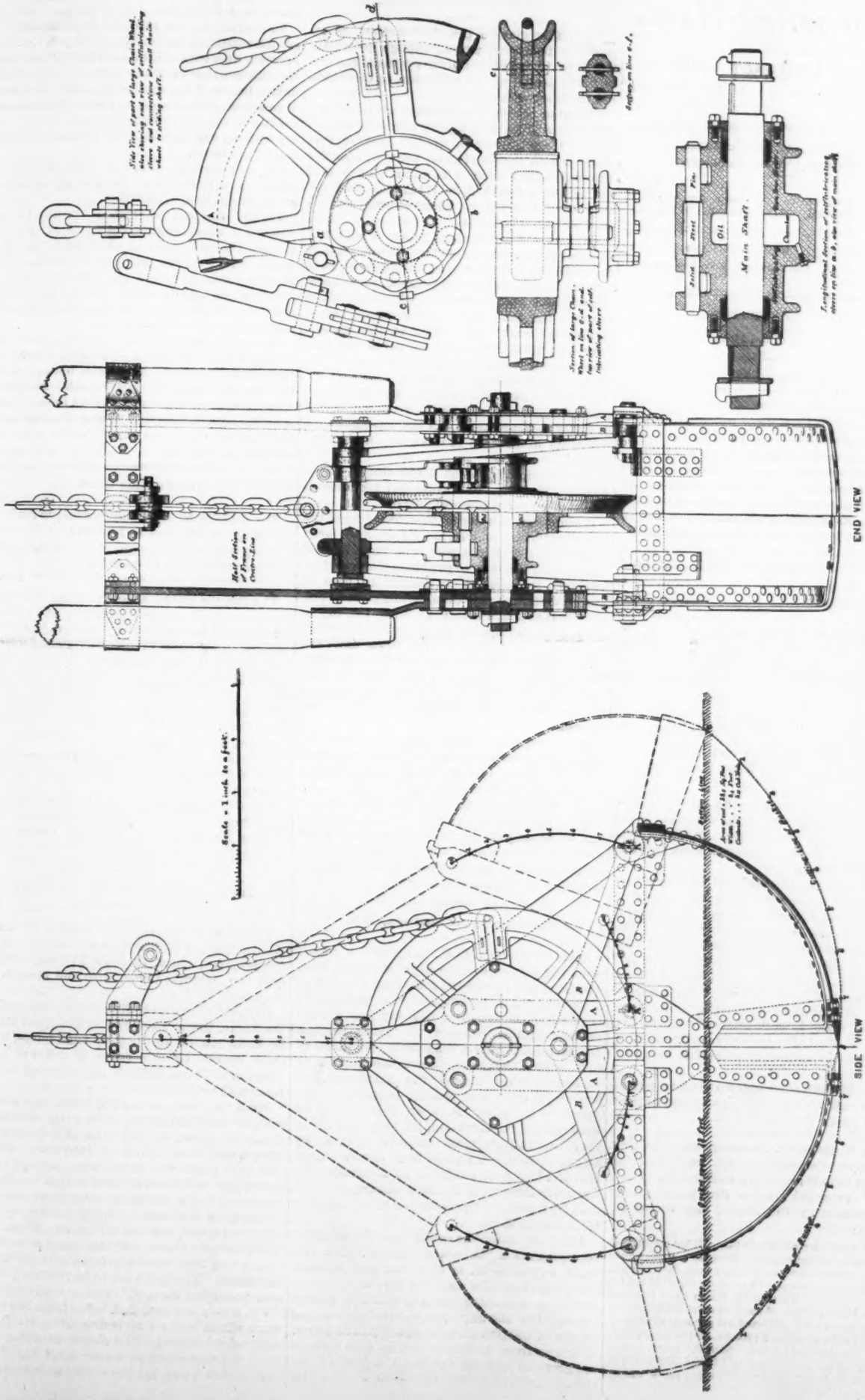
As long as these high prices can be maintained, and enormous profits are made and silently pocketed, very little will be done by the dredging fraternity to change these conditions, or introduce any new machinery.

An Old Tunnel.

After years of exertion the present governor of Samos, Abyssides Pasha, has succeeded in uncovering the entrances to a tunnel of which Herodotus speaks with admiration as the work of Eupalinos and Megaira and which, according to the same authority, was built during the tenth century B. C.

The tunnel, about five thousand feet long, was intended to secure a supply of fresh water to the old seaport town of Samos, and consists of three parts. These are: The tunnel proper, $5\frac{5}{8}$ feet high and 6 feet wide; a canal about 5 feet deep and nearly 3 feet wide which runs in the middle or on the side of the base of the tunnel, and the aqueduct running in this canal. The aqueduct consists of earthern pipes, each $2\frac{1}{2}$ feet long, 32 to 33 inches in circumference, the sides averaging about $1\frac{1}{2}$ inches in thickness. Every other joint has a hole, for what purpose has not yet been fully explained. Mr. Stamatiades, a Greek archæologist, believes that they were intended to facilitate the cleaning of the pipes, and to make the flow of water easier. The canal is arched over, but twenty-eight manholes were provided to admit the workmen who were charged with cleaning and repairing the aqueduct. The tunnel is not quite straight, forming an elbow about 1,300 feet from one of the entrances. This elbow, according to Stamatiades, was caused by a mistake in the calculations of the engineers, who had none of the instruments used in tunnel-building nowadays. The tunnel starts near a small water course which may have been quite a stream in olden times, pierces the mountain Kastri which was formerly crowned by the fort Samos, and ends a few hundred yards from the old town of Samos, about ten feet below the surface. From the mountain slope to the city this subterranean aqueduct is protected by a massive stone structure, ending within the walls of the present convent of St. John. The preservation of this work—which is truly wonderful considering the imperfect mechanical resources at the disposal of its builders—for nearly three thousand years is probably due to the care taken by Eupalinos, who in all places where the rock did not seem of sufficient firmness lined the tunnel with several layers of brick, running on the top into a peaked arch.

A GERMAN paper says that a roof can be made fireproof by covering it with a mixture of lime, salt and wood ashes, adding a little lampblack to give a dark color. This not only guards against fire, it is claimed, but also in a measure prevents decay.



THE BOTH DREDGING BUCKET.

PATENTED SEPTEMBER 26, 1882.

Engineering News

AND

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Make all drafts, cheques and money orders payable to **Engineering News Publishing Co.**

WHILE fully appreciating the telling points, artistic work, and general finish displayed in the cartoons of our comic neighbor, *Puck*, we must remark that they are sometimes weak from an engineering standpoint.

A few weeks ago General Butler was represented in a vigorous but intended-to-be futile effort to hoist himself into the Presidential Chair, but the artist supplied him with all the necessary mechanical appliances for so doing, in the shape of a substantial rope and pulley.

Last week, John Kelly and General Butler figured in an attempt "to stop" the wheel of the Reform Mill by hanging on to the buckets; but as the wheel is an "overshot" and the two men are in *front* of it, they are really assisting the movement instead of retarding it as intended.

We would advise the enterprising managers of *Puck* to attach a consulting engineer to their editorial staff.

MR. E. H. RUDIGER, formerly with the New York Steam Heating Co., but now with the American Construction Co. at Harrisburg, Pa., has just returned from a two months tour of observation in the South, and writes us, July 27th:

"I had a very interesting trip through the South, and was very much surprised and pleased to note the progress made in that section. I met a man in Alabama, chief engineer of one of the most successful furnace companies in the South, who claims to have successfully solved the process of making steel directly from the ore without any intermediate process such as is necessary in the Bessemer process, and at a cost one-third less than by that process, and of the native ores of the South. If his claims are well founded, the rate of progress in the South within the next ten years will be double that of the last ten."

Methods of Estimating Distances.

La Nature gives a practical method of estimating distances, which, though primarily intended to facilitate military operations, can be made useful to the engineer in obtaining rough topographical notes.

The plan proposed is to draw upon a card, silhouettes or outline figures of a man, standing erect, another kneeling, and another still walking with person slightly bent. Make the standing figure about 1 in. (25 mm) high, and the kneeling figure $\frac{2}{3}$ in. (16 mm). Next cut out these figures leaving a semi-circular base of card by which to hold it.

To test the apparatus, place a man, of average stature, 656 ft. (200 m) distant; allow an assistant to hold the card-figures at such height as you direct, and yourself move back exactly four paces, or about 9 ft. 10 in.; sight towards the man and if your figure corresponds in height and width to the distant man, you are in possession of one of the simplest and most portable of telemeters; if you miss it the first time, try again.

La Nature says that this process can be applied to distances of 3,000 ft. or more, and out of thirty measurements, all but one showed a deviation in distance of less than one twenty-second.

The principal involved is the simple one of similar triangles, and while not accurate it might often serve a useful purpose.

A somewhat simpler method based upon the same general principle, is one we have seen used during the late war and since, in field operations. This is, to graduate the top of an ordinary lead pencil by stationing men at known distances and then, holding the pencil erect and at arm's length, to bring the top of the pencil and the top of the man's head in line, and slip the thumb-nail down until the line of sight over the nail strikes the feet. The lengths on the pencil thus found, for 500, 1,000, 1,500, etc., feet are permanently marked on the pencil and the telemeter is ready for use.

To preserve a constant distance from the eye and to steady the hand, it is well to attach a small strong thread to the pencil with a knot at the end to be held by the teeth.

In a cultivated country where men are not always in place to be sighted upon, the scale can be arranged to take in an ordinary fence post, the height of which is sufficiently constant, to furnish the rough estimate of distance obtained by any similar method.

The Sewerage of Madison, Wis.

Allan D. Conover, C. E., has made a report upon the sewerage of the city of Madison, Wis., and from it we make the following extracts:—

Population, in 1880, 10,324. The topography is peculiar, inasmuch as the city lies upon a narrow isthmus between the lakes Monona and Mendota, with a maximum elevation of 80 ft. above the lakes; from the central or highest portion, ridges run northeast and southwest upon and nearly parallel to the shores of the lake. Between these spurs, on both sides of the elevation, lie large bodies of very low land, almost entirely covered by stagnant water. This low land is now valueless and has been rendered so apparently by the gradual rising of the lake waters, and can only be recovered by restoring these lakes to their former level.

After discussing the conditions, Mr. Conover recommends a "Separate" System, with two main sewers 15 in. in diameter and laterals from 6 to 12 in.: the mains to have overflows to the lakes; collecting tanks to hold the sewage delivered in the night; duplicate direct-acting pumps of 1,000,000 gallons capacity in 12 hours, to deliver from tanks through an iron main to the grounds selected for the disposal of the sewage: and to purify the sewage either by Broad Sewage, Farming, or by Intermittent Downward Filtration.

To provide for the rain-fall he proposes to use the existing channels to the lakes, for the present, with covered drains in the city proper. He suggests that in other portions the lower half or invert of the conduit be built in place of concrete, and so used as open drains until the land is required for building purposes, when the arching can be completed in brick and the conduit covered.

He estimated the cost of the collecting system at $77,612.50, and the sewage disposal at $52,660.00; total $130,272.50

For the disposal of sewage by the Broad Sewage, Madison would require 50 or 60 acres of land, the main body of which would be kept cultivated. For the Filtration system 15 to 20 acres would be sufficient. The first method requires the largest outlay of capital but is most economical in operations, while the contrary is true of the second.

We would remark that were it not for the fact that Mr. Conover is personally known at this office, we would have been unable, from the report, to locate this especial Madison. There are about twenty Madisons in the U. S. and the report fails to give any indication of the *State*, either in the report itself, upon the cover or in imprint.

The Panama Canal.

The *Bulletin du Canal Interoceanique* for July 7, 1884, gives progress as follows:

Work done in June, 1884..	933,000 cu. yds.
Total work done to June 30, 1884.....	8,804,403 cu. yds.

The *Bulletin* quotes at length from the *Capitaliste* an article severely attacking the gloomy reports spread abroad by telegraphic dispatches from New York and Philadelphia, and asserts its full confidence in the prophecies of M. de Lesseps and his advisory Council. It says that the majority of the council of administration are old and solid directors in the Suez Canal; and the majority of the subscribers, having quadrupled their money at Suez expect to do the same at Panama. The reports denounced are ascribed to American jealousy.

The *Bulletin* also presents an illustrated extract from *Le Monde Illustré*, describing the Osgood Excavator, the Hercules Dredge and other types of machines used.

The Proposed Canal from the Atlantic to the Mediterranean Sea.

Les Annales des Travaux Publics, for July, 1884, contains a plan and short description of the proposed canal through France, to connect the Atlantic Ocean with the Mediterranean Sea.

To avoid the natural difficulties presented at Bordeaux, the western end of the canal starts at Arcachon, on the bay of that name, near Cape Ferret; by this route 37 miles is also saved in the total distance as compared to the Bordeaux project.

From the point named the canal runs northeast, striking the valley of the Garonne near Langon, follows the left bank of this river to Castel, and then across to Toulouse. From this last point the canal runs almost in a direct line to Narbonne, and enters the Mediterranean Sea at Gouissan, near Narbonne.

The total distance from sea to sea, by the approved route, is about 267 miles. From the Atlantic side there will be eight ascending levels, and nine descending towards the Mediterranean. The locks are to have lifts of 30 ft. and multiples thereof. The summit level is 557 ft. above the sea, and is fed from the Garonne which has an elevation of + 644 ft. in that neighborhood. The depth of water will be 25 ft.; the width at water level, 120 ft. in rock cutting, and 147 ft. on embankments for

single way and 203 ft. for double-way. The deepest cutting is 163 ft. at Naurouse. The scheme is under examination by a Board of Engineers. Messrs. Bord & Hersent, as prospective contractors, have already made a tender for the work at a rebate of 3 per cent. upon the estimate cost.

The Arlberg Tunnel.

The masonry-lining is now finished and the road-bed is being built. According to the contract the work was to be completed ready for traffic within 180 days after the meeting of the two advance galleries. The work has been pushed with great energy, in the west end, where 1¼ miles remained unfinished owing to difficulties of execution; the average daily progress in the masonry-lining was 26½ lin. ft. during March and 21½ in April.—*Moniteur Industriel*, July 10.

The Juragua Mines, Santiago de Cuba.

We make the following extracts from *El Eco de Cuba*, of July 6th, relating to an American railroad and mining enterprise in Santiago de Cuba:

On July 5th, the railroad leading from the coast to the Juragua Iron Mines was opened to traffic. This road was built by the Juragua Iron Co., made up of the Bethlehem Iron Co. and the Pennsylvania Steel Co., of Harrisburg, Pa. Work was commenced late in July, 1883, and to the present date, 27 kilometers, or 16¾ miles, have been finished, connecting the first mine, the Firmaza, with the company's dock on the coast.

The line is narrow-gauge, with maximum grade of 2.8 %. There are eight wooden bridges and one iron viaduct, 800 ft. long and 42 ft. high, at Aquadoris, which the editor of *El Eco* refers to as a "stupendeous structure." The estimated cost of the road is about $1,000,000, $600,000 expended in labor and $400,000 for material and rolling-stock.

A shipping-dock of iron, 375 ft. long and 45 ft. high is now being built by the Phœnix Bridge Co. The chief engineer of the company is Mr. Paul S. King, of Philadelphia; Mr. S. D. Kynor has charge of the mining operations and has already collected 10,000 tons of ore at the mines ready for shipment; Mr. W. H. Nicholas is Superintendent of the road.

The hauling of the first 100 tons of ore to the shipping-dock was celebrated by Chief Engineer King by inviting about fifty of the local dignitaries to an excursion over the line. Among these was the editor of *El Eco*, and he can hardly find words to adequately express the surprise of the party at the "American energy" displayed in the completion in so short a time of this "great railroad," nor the general appreciation of the hospitality extended to them by Mr. King and his associates; many laudatory speeches were made and "cool drinks" partaken of.

Engineering Model Building for Japan.

For some months past the authorities of the Japanese Imperial University of Tokio, have been considering the most suitable place at which to have built an extensive collection of models and machinery for the Engineering Department of their University.

An informal letter was received some days since by Prof. O. H. Landreth, of the Vanderbilt Engineering School, and more recently the official document arrived ordering:

A model of wrought-iron highway truss bridge 6 ft. in length, to be built in brass.

A small working compound steam engine, with expansion gear and reversible gear.

A small working iron turbine water-wheel with water governor and sluice-gate.

Two differently constructed cast iron models of steam engine pistons with metalic packing rings.

A working model of engine's slide-valve and expansion valve, with adjustments and appliances for indicating the relative positions of piston and valves at any part of the stroke.

A working model of a surface condenser for a compound engine.

A working model of an improved pendulum-governor for steam engine, with adjustment for regulation of throttle valve.

The work on the above list of machinery will be commenced in the school shops of the Engineering Department as soon as the session opens, and will be pushed ahead as rapidly as possible, consistent with good shop instruction for the engineering students, who will do the greater part of the work, and as the number of students will be sufficient, it is probable that duplicates of the above will be built at the same time.

A small vertical engine, built largely by last year's engineering class, was intended for exhibition at the World's Fair at New Orleans during the coming fall, but cannot be spared, as it will be needed to run the blowing fan for the cupola of the foundry and for the forges which are too remote to take their power from the regular steam engine.

The order for the truss bridge was accompanied by working drawings in blue print, which are very creditably executed. The other items of the order are to be designed as well as constructed at the Vanderbilt.

The University of Tokio was organized in 1860 around the old Imperial Observatory, which was founded in 1744, as a nucleus

The instruction is in Japanese, except in the Schools of Law, Chemistry, Engineering, Polytechnics, and Mining, in which the instruction is in English. The School of Engineering is under the charge of Prof. J. A. L. Waddell, an American engineer of recognized ability.

Hoisting and Heating Plant of the Mutual Life Building.

In the immense buildings devoted to offices which have been put up in this city during the last few years, the arrangements for heating, hoisting, lighting and fire protection assume large proportions and considerable importance. No building is more complete in its system of apparatus for accomplishing these objects than that of the Mutual Life Insurance Company. In the sub-basement are four Babcock and Wilcox water tube boilers, 488 horse power in all, supplying steam at 80 lbs. pressure for the heating apparatus and pumps.

There are two Otis hydraulic elevators, geared 4 to 1, the water pressure by which they are operated being derived from a tank on the roof. To force the water up into this tank, a height of 151 ft., there are two compound duplex Worthington pumps of 18 in. stroke, plunger 16½ in. in diameter, high pressure cylinder 18½ in. and low pressure 29 in. in diameter. These pumps are self regulating through the ordinary system of pressure diaphragms acting on the throttle. Besides these pumps there is a Clapp and Jones fire engine, steam cylinder 16 × 9 and water cylinder 16 × 7½, throwing 1,000 gallons a minute at 240 revolutions, and a Knowles pump raising water from a well 200 ft. in depth. A second source of water supply is an artesian well 907 ft. deep and discharging 18 gallons.

The building is lighted by an electric plant on the Sawyer-Mann system, consisting of 9 dynamos, running 200 lights each. The power is supplied by four Westinghouse engines, 10 x 10 cylinders and developing 50 horse power at 300 revolutions.

The heating is done by steam on both direct and indirect methods, the steam being reduced from the boiler pressure of 80 lbs down to 10 lbs. by the Curtis regulating valve, manufactured by the Curtis Regulator Company of Boston, which was found after experiments conducted in the presence of the superintending engineer of the building, Mr. John L. Wilkinson, to best answer the required purpose.

PERSONAL.

MEXICO July 14, 1884.

CIRCULAR.—Having been granted leave of absence, MR. H. H. FILLY is hereby appointed acting Chief Engineer during my absence,

G. W. VAUGHN.
Chief Engineer, Mexican National Railway

MR. VAUGHN has been given leave of absence to visit his home in Leavenworth, Kansas, while negotiations are pending for capital to complete the construction of the main line.

DAVID O. SAYLOR, whose death was announced in our last issue, was born in Hanover Township, Lehigh Co. Pa., on Oct. 20, 1827. In early life he assisted in his father's store, at Buthtown, and at Schoœnersville, Pa. In 1865 he came to Allentown, and after about one year's residence there his attention was attracted to the cement property at Coplay. In 1868 the Coplay Cement Co. was chartered, the stockholders being MR. SAYLOR, MR. REHRIG and the late ADAM WOOLEVER.

This concern started upon a small scale, with MR. SAYLOR as President and Superintendent, but owing to the energy of this officer it grew until it has at present a capacity of 100-000 barrels of cement a year. It was through the personal labor and careful study of the subject by MR. SAYLOR that his "American Portland" cement was finally produced, an i a brand given to the consumers of the country equalling in its good qualities its English namesake.

GEORGE J. SPECHT, C. E., whose contributions have appeared from time to time in this journal, graduated in 1874 from the Polytechic School, in Gratz, Austria, with the highest honors of his class. He was at first employed in the office of the "Crown-prince Rudolf" R. R., in Vienna, but in 1875 accepted a position on the St. Gothard Railway, proffered him by his friend MR. HELLWAG, Chief Engineer of that road. MR. SPECHT was Assistent Engineer upon the Division including the Pfaffensprung Tunnel, and with his personal friend MR. BRANDT, also an Engineer on the St. Gotthard R. R., attended the first trials of the Brandt-drill, (described in ENGINEERING NEWS, January 19, 1884) which has since proved so very successful in the driving of the Arlberg Tunnel.

Leaving the St. Gothard R. R. in 1877, MR. SPECHT went to San Francisco, Cal., where since that time he has been actively employed in his profession as a Civil Engineer. He was for nearly two years Assistant Superintendent of the Sutro Tunnel, for some time Assistant Superintendent of the New Alameda Quicksilver Mine and, as Chief Engineer, engaged in the projection and building of extensive irrigation and drainage works.

MR. SPECHT is an enthusiast in his profession and has devoted himself for sometime past to the organization of the "Technical Society of the Pacific Coast," his efforts in this direction being recently crowned with encouraging success.

A DIFFICULTY that has for a long time puzzled the engineers of the St. Gothard Railway seems on the point of being removed. In passing through the great tunnel, the passage of which occupies fully twenty minutes, the sulphurous fumes from the engines render the confined atmosphere injurious to persons with delicate lungs. The company requested their engineers to submit plans for engines that would be capable of passing through without using fire. Two experimental locomotives, just completed, are provided with steam and water that is heated by a stationary boiler at each end of the tunnel. The steam thus generated is passed by means of a current of hot air, which is set in motion by the working of the engine, over an alkaline liquid, confined in a special chamber, and by this means is entirely absorbed after having communicated its power to the machinery, so that no vapor at all escapes into the atmosphere of the tunnel.

TURNOUTS:

Exact Formula for their Determination, together with Practical and Accurate Tables for Direct use in the Field.*

BY W. B. PARSONS, JR., C. E., ROADMASTER NEW YORK AND GREENWOOD LAKE DIVISION, ERIE RAILWAY.

(Continued from page 44.)

CROSSOVERS.

1st. Case—When Parallel Tracks are Straight.

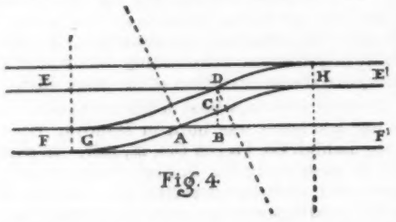

Fig. 4.

Let EE' and FF' be the two parallel tracks to be joined by a crossover, the distance ($DB = d$) between them being known. Let GH represent the crossover, with the frogs at A and D; these frogs will have the same angle. The two parts of the crossover AG and DH are merely single turnouts, the various relations of which can be computed by formulæ 1 to 3, or taken directly from Table No. 1. All that remains to be found is the distance AB, or the distance between the frog-points measured on one of the parallel tracks.

Since the frogs have the same angle it is evident that the piece of track connecting the two turnouts AG and DH must be straight.

Therefore, $AB = \frac{BC}{\text{tan. } F}$, where F = frog-angle BAC.

But $BC = DB - CD$, in which $DB = d$, and $CD = \frac{g}{\text{cos. } F}$; whence, by substitution

$$AB = d - \frac{g}{\frac{\text{cos. } F}{\text{tan. } F}} = \frac{d \text{ cos. } F}{\text{sin. } F} \qquad (12)$$

2st. Case—Where Parallel Tracks are Curved.

Assume arrangement of tracks as shown in Fig. 5. Without going into complex calculations, the distance betweeen frog-points, measured midway between the two tracks, can be taken as deduced by formula 12; this is practically true.

TABLE No. 2.—Giving in feet the lengths of the radii of the Curves of the Turnouts from the Inside and Outside of 1° to 10° Curves.

Degree of Curvature of Main Track	Location of Frog	FROG NUMBERS							
		6	7	8	9	10	11	12	13
1°	Inside	319.93	426.85	545.09	672.87	808.42	950.02	1096.05	1244.97
	Outside	**360.47**	**502.04**	**673.79**	**880.24**	**1127.33**	**1422.83**	**1777.14**	**2244.32**
2°	Inside	302.88	397.08	497.51	601.88	708.14	814.53	919.62	1022.26
	Outside	**384.81**	**550.45**	**763.84**	**1040.36**	**1403.88**	**1893.38**	**2576.58**	**3583.05**
3°	Inside	287.55	371.18	457.56	544.40	629.94	712.80	792.04	867.07
	Outside	**412.66**	**609.13**	**881.56**	**1271.40**	**1859.62**	**2827.52**	**4680.32**	**9550.83**
4°	Inside	273.68	348.44	423.52	496.93	567.27	633.62	695.50	752.70
	Outside	**444.81**	**681.74**	**1041.96**	**1633.85**	**2752.09**	**5575.45**	**25375.34**	14387.85
5°	Inside	261.09	328.31	394.18	457.05	515.91	570.25	619.90	664.96
	Outside	**482.34**	**773.88**	**1273.44**	**2284.36**	**5286.23**	**190712 16**	7427.76	4106.49
6°	Inside	249.60	310.38	368.64	423.08	473.07	518.37	559.10	595.51
	Outside	**526.74**	**894.64**	**1636.48**	**3792.53**	**65831.91**	5929.08	3241.63	2396.24
7°	Inside	239.07	294.29	346.19	393.81	436.78	475.14	509.14	539.18
	Outside	**580.07**	**1059.82**	**2288.00**	**11133.97**	6306.39	2921.02	2074.16	1692.33
8°	Inside	229.39	279.79	326,32	368,31	405,65	438.55	467.37	492.57
	Outside	**645.31**	**1299.41**	**3797.98**	11931.92	3011.22	1938.76	1525.52	1308.47
9°	Inside	220.47	266.65	308.60	345.91	378.66	407.10	431.99	453.37
	Outside	**726.96**	**1678.26**	**11138.54**	3888.23	1978.76	1451.42	1206.77	1066.84
10°	Inside	212.21	254.68	292.70	326.68	355.04	380.00	401.48	419.95
	Outside	**832.68**	**2367.47**	11978.86	2323.94	1474.09	1160.18	998.46	900.75

TABLE No. 3.—Distances between Frog Points on Crossovers when measured on Parallel Tracks.

Frog Number.	DISTANCES BETWEEN TRACKS.											
	ft. 7	ft. in. 7 6	ft. 8	ft. 8	in. 3½	ft. 8 6	ft. 9					
	ft. in.	ft. in.	ft. in.	ft.	in.	ft. in.	ft. in.					
6	13 3¼	16 3	19 2¾	20	11¾	22 2½	25 2¼					
6½	14 5½	17 8¼	20 11	22	9½	24 1¾	27 4½					
7	15 7½	19 1¾	22 7	24	7½	26 1	29 6¾					
7½	16 9½	20 6½	24 3¼	26	5¾	28 0	31 8¾					
8	17 11¾	21 11½	25 11¼	28	3¼	29 11	33 10¾					
8½	19 1½	23 4¾	27 7¼	30	1	31 10	36 1					
9	20 3½	24 9¾	29 3¼	31	10¾	33 9¼	38 3					
9½	21 5¾	26 2¾	30 11¼	33	8½	35 8¼	40 5					
10	22 7½	27 7½	32 7½	35	6¼	37 7	42 7					
10½	23 9¾	29 0¾	34 3¼	37	3¾	39 6	44 9					
11	24 11¼	30 5¼	35 11	39	1½	41 5	46 10¾					
11½	26 1¼	31 10	37 7	40	11¼	43 3¾	49 0¾					
12	27 3	33 3	39 2¾	42	8¾	45 2¾	51 2½					
12½	28 5	34 7¾	40 10¾	44	6¼	47 1½	53 4½					
13	29 7	36 0¾	42 6¾	46	4	49 0½	54 6¼					

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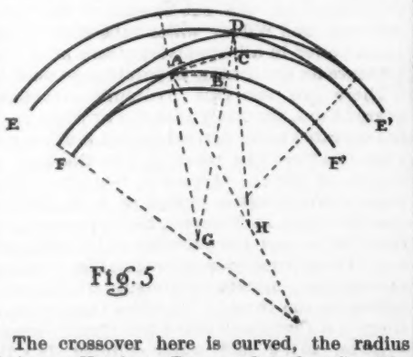


Fig. 5

The crossover here is curved, the radius being $AH + \frac{1}{2}g$. Draw AB and AC. The triangles AGB and AHC are similar, because they are isosceles and have equal angles at the vertices G and H.

Then, $AG : HC :: AB : AC$.

But AC is greater than AB, therefore HC is greater than AG.

The radius of crossover $= HC + \frac{1}{2}g$.

The radius of inside track $= AG - \frac{1}{2}g$.

Therefore radius of crossover is greater than the radius of inside track. (13)

The turnout portions comply with previously deduced rules.

TO BE CONTINUED.

CORRESPONDENCE.

Wood Pipe in Detroit.

Special Correspondence Engineering News.

BAY CITY, MICHIGAN, July 26, 1884.

EDITOR "WATER" COLUMN, ENGINEERING NEWS.—In your issue of July 19, 1884, you state: "The Detroit Water Commissioners are replacing their wooden pipes with iron." Having made this statement, which, as it stands is a condemnation of our wood pipe, we trust you will also publish the enclosed letter from Mr. H. Bridge, Supt. of Detroit Water-works, and also this letter.

In regard to the decay of which Mr. Bridge speaks we can say, that wood pipe made as it is to-day is never so affected. In the first place the sap, which is the decaying part later, is all taken off, and after the pipe is banded, it is coated with an impervious and non-destructible cement, which is an absolute preservative. We never have had trouble with our pipe and judging from past experience never will have.

Hoping you will give this as prominent a position as you did the charge against wood-pipe, we are,

Yours truly,

THE MICHIGAN PIPE CO.

WATER COMMISSIONERS' OFFICE, DETROIT July 24, 1884.

HENRY B. SMITH, ESQ.
Secretary and Treasurer of The Michigan Pipe Co.
Bay City, Mich.

DEAR SIR;—In reply to yours of 22d inst. I have to say that, whatever may have been inserted in ENGINEERING NEWS, I am not responsible for; not having had any correspondence with that paper, and why it should represent that the log pipe discontinued in Detroit was your make,* I cannot conceive. The log pipes we have in use are made of tamarack logs, not banded, only having ferules of band iron drive on each end. The said logs are not being taken out on account of decay altogether, but more particularly to give place to larger pipe, as most of our log pipe are only 2¾ bore. We have logs still in use that have been in the ground twenty to thirty years. In my opinion the rapid decay of logs depends upon the nature of the ground they are laid in. We have still in use 78 miles of them. Hoping the above may meet your wishes, I am,

Yours truly
H. BRIDGE,
Supt. D. W. W.

* We did not.—ED. ENGINEERING NEWS.

STATE OF MICHIGAN, COUNTY OF BAY } ss.

F. C. Finkenstadt being duly sworn, deposes and says that the above is an exact true copy,

R. FINKENSTADT.

Subscribed and sworn to before me this 26th day of July, A.D. 1884.

J. H. HILL,
Notary Public in and for Bay County Mich.

Corrosion of Cast-Iron Pipes.

Special Correspondence Engineering News.

NEW YORK, July 29th, 1883.

EDITOR ENGINEERING NEWS.—Absence from the city on an important hydraulic case has prevented me from seeing the needlessly alarmed offer of the Cincinnati & Newport Iron Pipe Co., in your issue of the 19th. As I have not laid any water mains for about six years, I was careful not to include more recent practice in what was said in explanation of the general subject discussed. If our foundries have universally reformed one objectionable feature in casting, as this correspondent asserts, it is a step in the right direction for which credit is due, and ought to go on record. As to the practice under which the great body of city distribution has been laid, I have ample personal knowledge, and it was this practice which my Paper discussed.

Conceding frankly, whatever is to be conceded, and rendering honor where honor is due, suppose we help this question, as raised, to a practical solution. What ENGINEERING NEWS wishes to promote is, better foundry work in materials so exposed as are our gas and water mains. I am preparing plans now for the use of a number of miles of pipe, and am pers onally interested.

I would be obliged, therefore, if the Company will furnish the NEWS with a statement of their last contract filled, as to dimensions and weight of pipes, and a copy of their specifications, covering their casting, coating and inspection.

In addition I should like, from the Engineer-in-charge a statement of the number of rejected pipes and causes; of the caliper tests of thickness, concentric forms and tests of line; of the hammer tests and results; of the actual weight in range, for each size; and of the fracture, quality and tensile strength of the "pig" used, and the certificate of a chemist of repute, of his analyses of the pipe metal from average specimens, giving, in particular, the specific gravity and the per centum of combined and uncombined carbon.

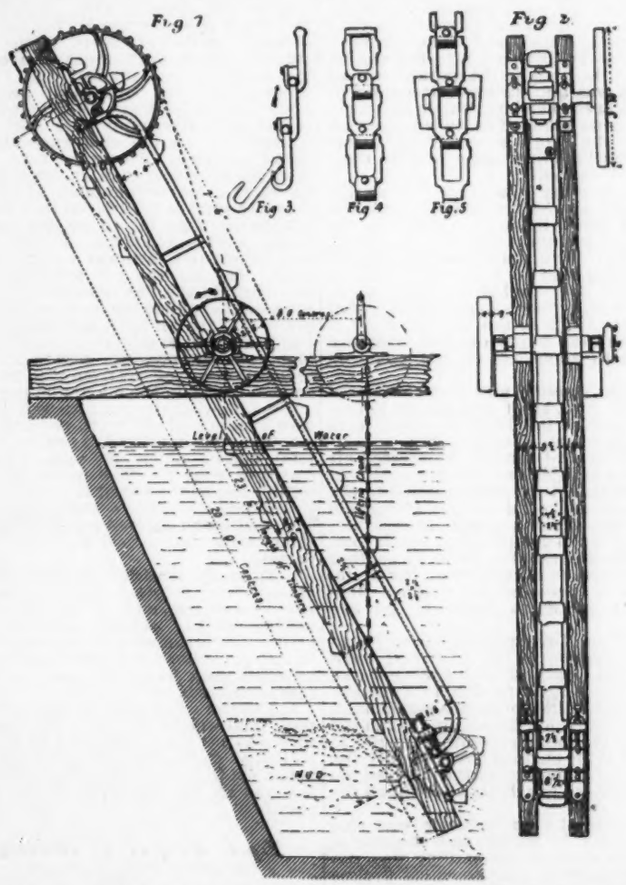
With these notes, which I have no doubt they will gladly furnish, we shall have a valuable record of progress in distribution service, and an important fulcrum for greater improvement in the same direction.

Yours respectfully,

SAMUEL McELROY.

Hall's Suspended Dredger.

We annex an illustration from ENGINEERING of a small dredger, especially adapted for clearing small watercourses, ditches, reservoirs, etc. As will be seen by the drawings, it consists of two long timbers spaced 9½ in. apart and carrying between them, at top and bottom, the pitched wheels over which the bucket chain travels. These timbers are supported on horizontal bearers, which are laid either from bank to bank, or on suitable supports. Upon the same bearer is mounted a shaft, carrying at one end a wheel turned by a handle and serving to drive by a strap a wheel running in bearings on the main timbers of the dredger. On the other end of the shaft upon which the second wheel is mounted, is a small pitched wheel, over which a chain



HALL'S SUSPENDED DREDGER,

passes, which rises to the top of the apparatus, where it actuates the driving bucket wheel. The chain carrying the bucket passes down over the wheel at the dottom of the dredger, and the adjustment of which is effected by set screwe as shown. A special feature of this dredger is the use of Hall's driving chain, which is illustrated by Fig. 3 to 5, and which is made up of malleable iron, or stamped out in wrought iron. Fig. 5 shows the form of link used for attaching the buckets. Figs. 3 and 4 illustrate the driving chain. It will be seen that the links are held in place, each by a single block and screw, and that they can be replaced with very little trouble. The dredger which we have described was designed and constructed by Mr. C. S. Hall, of Sheffield, Eng.

GRANULATED cork is an excellent non-conductor of heat, and is on this account a very desirable material in the construction of refrigerator cars. It is also used in the floors of passenger cars as a "deadener" of the noise of the running gear.

Westport (Conn.) Bridge.

At a recent meeting of the Town of Westport, Conn., the minority report of the bridge committee was adopted. This report provides for the construction of a bridge according to the plans submitted by Mr. C. V. N Kittredge of the Union Bridge Company.

The general specifications provide for a draw span 144 feet total length, placed upon a circular draw pier 20 feet in diameter. The draw will revolve either way upon a steel pivot in the center of the pier. Also upon cast iron wheels radiating from the center pivot and running between circular tracks resting upon and near the outer edge of the pier, and on the under side of the turn table. The weight of the draw span being carried principally by the steel pivot, and the wheels serving to keep the draw in position. This method reduces the friction to the minimum and allows the draw to revolve easily.

A protection to the draw span, extending up and down the river from the draw pier, will be constructed of yellow pine timber, and extend from the bed of the river up above high water line, being partially filled with stone to hold it in place. The side next the channel will be planked longitudinally with 3 inch yellow pine plank, from above high water line down six feet; this planking will be continued past the draw pier so as to afford a complete and smooth guide for vessels passing when the draw is open.

The fixed span will be 142 feet in its entire length, the road way being 20 feet in width and having head room of 14 feet in the clear.

The two spans (the draw and fixed) will be what is known as "pin connected" work, and will be designed and constructed upon the most approved methods of modern bridge construction, from thebest wrought iron, manufactured expressly for this bridge. No cast iron will be used in the trusses.

The floors will be covered with the best yellow pine plank, 3 inches in thickness, laid upon 3"×12" yellow pine joists, supported at panel points by wrought iron floor beams.

The sides of the roadway will be protected by wheel guards 8"×8", being placed on the top of the planking and secured to the floor with long screws. The bridge will be provided with a hand railing on each side.

To allow for contraction and expansion of the iron work produced by changes of temperature a nest of expansion rollers will be placed under one end of each truss.

All iron work will be painted with one good coat of oxide of iron paint mixed with pure linseed oil, before leaving the shops, and after erection the bridge will be painted with two coats of lead paint, of such color as may be desired by the committee.

The bridge is to be proportioned to carry in addition to its own weight a rolling or live load of seventy-five pounds per square foot of its roadway, and the floor system is proportioned to carry one hundred pounds per square foot, or 8000 pounds on each pair of wheels on two wagon roads.

The lateral and vibratory system is designed to resist a wind pressure of fifty pounds per square foot of exposed surface.

In no part of the bridge will the maximum strain produced by the above specified loads exceed one fifth of the ultimate strength of the material.

The wrought iron will be of the best quality, tough, ductile and fibrous, and have an ultimate strength of 50,000 pounds to the square inch: an elastic limit of 26,000 pounds, and an elongation before rupture of twelve per cent in eight inches.

All iron for tension members must bend cold 180° without cracking over a curve whose diameter does not exceed twice the thickness of the bar. Shaped iron must bend cold 90° without cracking.

The cost of the bridge when completed, including approaches, is to be 26,000 dollars.

The piers and abutments to be first class, rock faced work, laid in best hydraulic cement and carried down to hard bottom on a grillage of timber, the top of the timber in all cases to be under the mud in the river.

The embankment at the east end of the bridge will be made of earth, 24 feet wide on top, and then riprapped with stones on the sides from hard bottom up one foot above high water line in a substantial manner.

Transportation in the Arlberg Tunnel.*

COMPILED FOR ENGINEERING NEWS BY GEO. J. SPECHT, C. E.

The rapid completion of the Arlberg Tunnel, (described in this journal, of Jan. 19 and 26, 1884,) has attracted sufficient attention to warrant the following detailed description of the method of transportation of material adopted in prosecuting that work.

One of the most important questions to be solved in the construction of long tunnels, where work has to be pushed with all possible speed, is the removal of the excavated rock and the handling of the material required for masonry. Large masses have to be moved in a narrow dark space; the difficulties increase with every foot of advance, and the details have constantly to be adopted to the varying conditions of the ground. The system of transportation adopted therefore practically controls the rate of progress, and any mistakes made in this direction will sooner or later come to light, to give serious and unexpected trouble.

The *bottom*-advance heading, as at the Arlberg, permits a much more favorable arrangement for transport than the *top*-advance

* From the paper by Gustav Plate in the Proceedings of the Austrian Society of Engineers and Architects, July 7-14, 1883.

heading, employed at the St. Gotthard. In the first system the track is laid at once upon the proper road-bed and remains unchanged during construction, while in the second, or so-called Belgian system, the temporary track must be lowered from time to time as the work advances, and the material has to be lowered from the top-heading to the bottom of the tunnel, a distance usually of about 11½ ft.

At the St. Gotthard an attempt was made to lift, by a hydraulic elevator, the cars loaded with masonry material from the bottom to the top-heading. This was soon abandoned however owing to the difficulty of keeping the complicated machinery in order in the tunnel, and it s removal, as the enlargement was completed, consumed time and delayed other work. Steep inclines were then used, hauling up the cars by horses and lowering them by brakes; this plan was continued to the end. The inclines had a grade of 2.5 per cent. or 132 ft. per mile, a length of 425 to 500 ft. and a width equal to about one third of the tunnel. To facilitate proper working, it was desirable to have the "enlargement" behind the incline or towards the tunnel entrance and below the floor of the top-heading, connected as soon as possible laterally with the finished tunnel, so that transportation be made easier and the water permitted to run off. As long as this was not the case, the excavated material had to be raised to the top of the *rampe* and lowered down over the incline; the water also had to be lifted. If by any reason work was discontinued in isolated portions, the dirty water accumulated and contributed greatly to the contamination of the air in the tunnel.

Where the *bottom*-advance heading is used these difficulties do not exist, as no work beyond the final drainage ditch has to be done below the heading floor. In the Arlberg the apex of the grade is 13,420 ft. from the east portal and 20,300 ft. from the west entrance, therefore the last *Kilometer* of the east heading had to be worked on the down grade. But as hardly any water was there encountered, this gave little trouble.

The average advance made in the Arlberg Tunnel, the enlargement and the arching keeping pace with each other, was nearly 16 ft. per day, and was never reached in the St. Gotthard or any other tunnel. This progress was mainly due to the bottom-heading and the transportation system adopted as a consequence.

The method of handling material may be described as follows: From the dumps and the quarries to the face of the heading only one track, 28 in. gauge, was laid. This track remained unchanged and was simply extended daily according to the progress made. It was relaid for locomotives when a longer section of the tunnel was completed. At the end of the completed tunnel-section, where the locomotives stopped, was a side track equal in length to an average train, upon which the loaded cars from the heading had been pushed by men. From this side-track the engine took its train, leaving the empty cars upon the main-track, from which they were taken singly to the places of work. About 325 to 400 ft. back of the face was another short side track with switches at both ends. The cars of the incoming train being partly empty, and partly loaded with material for use inside, were arranged outside the tunnel in the order in which they were to be used at the thirty or more different workings, so that no switching was necessary inside. The cars to be used in the face came in first, carrying the material wanted there, as drills, drilling machines, powder, etc., then followed a car loaded with common hand-drills to be distributed in passing the various working-parties, (in going out these hand-drills were gathered up in the same way), then came the cars as needed in the workings.

The following figures will give some idea of the magnitude of this transportation service: The entire tunnel required arching; the excavation in good ground was about 592 sq. ft. in section, increasing to 860 sq. ft., for bad ground, the average excavation per lineal foot of tunnel was about 25.9 cu. yds., all this had to be carried to the dump. The masonry also varied in quantity from 4 to 12 cu. yds. per lineal foot of tunnel, this stone and cement, etc., as well as timber for the temporary support of the headings and enlargement, the arch-centers, ties, tools, rails, pipes, etc., had to be carried into the tunnel. The miners and laborers were likewise transported in and out at each shift. With an average progress of 16.4 ft. per day the approximate daily tonnage *out* of the tunnel was 880 tons (of 2,000 lbs.) and in the opposite direction 330 tons, this is the net weight, the cars which were solid and strong must be added to obtain the gross tonnage. Taking into consideration all the conditions, we may assume that with the above progress, 400 cars traversed the tunnel in each direction in every twenty-four hours, and the total tonnage in round numbers was 2,200 tons.

As the slightest irregularity or disorder in the transportation effects disadvantageously the entire progress in the tunnel, it is absolutely necessary to keep the track and cars in most excellent condition. In the Arlberg, the trains were moved out of the tunnel by gathering up all the cars, commencing at the heading, and moving them to the end of the locomotive track, called the "tunnel-station." During the interval between outgoing and incoming trains the track in the unfinished part of the tunnel was unobstructed, excepting by the rock-cars in the heading, which had to be moved after every blast. The loaded cars were placed upon the short inner siding, before mentioned, until the time came to push them to the "tunnel-station."

In the East-heading (grade 10.56 ft. per mile) the trains were moved from the "tunnel-station" to the dump by a locomotive; in the West-heading they were run out by gravity and brakes, the down grade being 79.1 ft. per mile. In coming into the tunnel the trains in both headings were pulled by locomotives. In the East-heading 2 men could push a loaded car either way; while in the West-heading, it required 2 men to an empty car and 4 men to a car loaded with about 0.65 cu. yds. going up grade.

Endless chain traction was first considered for moving the cars, but it was almost impossible to regulate the handling of cars so as to meet the requirements of this system.

In the St. Gotthard Tunnel compressed air locomotives (system MeKarsky) was used. At first the compressed air was supplied to the engines outside of the tunnel, but afterwards from the inside, from a large air-receiver, filled by a battery of compressors, which compressed the air, delivered to them by another set of compressors, to about 176 lbs., per sq. in. As the distance increased the engines were supplied from an extra reservoir on two flat cars.

The application of compressed-air to transportation in tunnels is the best and most feasible method, provided that sufficient and cheap power is at hand to compress the air. At the St. Gotthard this power was insufficient, there being at times hardly enough to run the drills, and the blowers and ventilators had to stand idle. As the engines traverse only the finished portion of the tunnel the air from the locomotive exhaust has little effect upon the ventilation.

At the Arlberg the water-power was also limited, especially in winter, and the use of compressed-air engines for hauling was not earnestly entertained. The so-called fireless locomotive of Lamm and Francq, with some improvements were adopted. The principle of this system is the use of steam with high tension, developed in stationary boilers, from which the engines are supplied. The steam is exhausted into a condensing reservoir filled with water; the pressure falls until it is insufficient to drive the locomotive when it is again filled up from the stationary boiler.

But as the steam might fall at some point in the tunnel when it was impossible to renew it, fire-boxes were added to the original design. The engines used at the Arlberg were built by Krauss, in Munich. In their construction these locomotives differed from the common type in their large boiler and low fire-box. They had their own tender, and were provided with a very sensitive regulator, which could be so adjusted that any reduction of the initial pressure of 221 lbs. was only caused by the resistance encountered on its way from the boiler to the cylinder, in which last the expansion was great.

The engine had a blast-pipe connected with two drafts; one of these, with an annular section, was used in connection with the steam to enliven the fire, the second carried the steam into the feed-water. The exhaust steam can also be allowed to escape into the air. The boiler was covered by the Laroy jacket.

The proportions of the engine were as follows:—track gauge 28 in., rigid base 4ft. 8in., cylinder 9 × 11½ in., diameter of driver 23 in., maximum pressure 221 lbs., heating surface 194 sq. ft., grate-area 3.1 sq. ft., capacity of boiler, 106 cu. ft., steam room 17¾ cu. ft., water space 88½ cu. ft.. Weight when ready for service 11 tons, tractive power, with 74 lbs. pressure, 1520 lbs.

Just before entering the tunnel the pressure is raised to 221 lbs. and the fire-place filled with coke and the ash-pit closed; the exhaust steam escapes freely. As long as the locomotive is underground no firing is done; when the pressure decreases, the engineer simply opens the regulator a little more. When the dump is reached the first thing done is to refill the boiler with water, then stir up the fire and raise the steam again to 221 lbs. preparatory to the next trip. As long as the tunnel was comparatively short one locomotive was able to do all the work and find time to refill, etc.; when the distance became too great the "fireless" engine was only used underground; an ordinary locomotive did the outside work.

Mr. Plate made the following observations on one of his trips:—East-heading, grade 10.56 ft. per mile, train going in made up of 40 empty rock-cars and 12 cars loaded with arch stone, total weight about 66 tons. At the entrance the steam pressure was 217 lbs., at a distance of 3000 ft., 191 lbs., at 4,600 ft., 176 lbs., at 6,600 ft., 162 lbs., and at the "tunnel station," 7,750 ft., the pressure was 156 lbs. The time was 18 minutes, and the consequent average speed about 5 miles per hour. They halted 2 minutes to uncouple the empty cars and attach the loaded train on the side track, the pressure rising to 163 lbs. The return train was made up of 36 loaded rock-cars, and 12, mostly empty, flat cars, a total weight of about 143 tons. The pressure sunk at 2,000 ft., on the return trip, to 147 lbs., at 5,250 ft., to 132 lbs., and at the portal, 7,750 ft., to 123 lbs. The time consumed was 15 minutes, average speed 6 miles per hour. The fire was not touched during the trip; outside the fire was stirred up and the same engine pulled the train to the dump, upgrade 15,84 ft., per mile, and brought back an empty train in 20 minutes. During a rest of 15 minutes the pressure rose to 221 lbs.; from repeated observations from 15 to 20 minutes is enough to regain the maximum pressure.

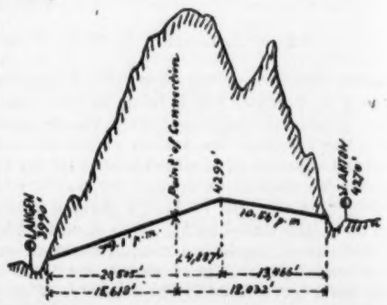
The following observations were made at the west-heading, grade 79.1 ft. per mile:

1. The train consisted of twenty loaded cars, total weight about 35 tons, and distance travelled 2,950 ft. The initial pressure was 209 lbs. and at the end of the trip 156 lbs., time six minutes; average speed 5½ mile per hour. The engine run back empty and without use of steam and maintained its pressure to the portal.

2. The train consisted of sixteen loaded cars, gross weight 29 tons. At the portal the pressure was 200 lbs., and at the end of the trip, 4,250 ft., 143 lbs. Average speed 3.7 miles per hour. During a stop of six minutes in the tunnel the boiler was filled by the injector; the pressure sank to 138 lbs. on the return, and rose afterwards to 140 lbs.

3. The train was made of twenty-four empty cars, total weight 31 tons. The initial pressure was 198 lbs.; distance 3,780 ft.; sunk to 150 lbs. at end of trip in speed 3.28 miles per hour. On the return trip the pressure at starting was 127 lbs., this rose to 133 lbs. at the portal.

Fig. 1. Profil of Arlberg-Tunnel



As shown on Fig. 1 the last part of the east-heading had to be worked on a down grade. In the west-heading the capacity for work of the engine was reduced by reason of the heavy grade, 79.1 ft. as opposed to 10.56 ft. per mile in the east, two locomotives were required when the distance became greater. The 28 in. gauge should have been 40 in. permitting the use of a more powerful engine.

The bright fire under the boiler, remained unchanged when the draft was shut off. Although the developement of carbonic-oxide could not be entirely prevented, the amount of bad gas generated was too small to make any appreciable trouble in the tunnel, the ventilation of the tunnel was strong and effective.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E. : M. INST. C. E.

(*Continued from page 47.*)

DCLXII. FORT WORTH, TEX.

Fort Worth, Texas in lat. 32° 40′N., long. 97° 15′ W., the county seat of Tarrant County is in rolling prairie land at the junction of Trinity and Clear Fork Rivers.

Water-works were built in 1882 and 1883 by a private company after plans and under the direction of M. C. Orton, C. E., taking the supply from Trinity River.

Two wells each 20 ft. square and 16 ft. deep are sunk in the gravel bed of the river, the water coming in from the bottom, and being pumped thence directly into the mains by a quadruplex Holly steam pump of 4,000,000 gallons daily capacity giving an ordinary pressure of 60 lbs. and a fire presure of 120 lbs. A duplex Worthington steam pump of 750,000 gallons daily capacity is also used.

Distribution is by 11½ miles of cast-iron pipe of 20 to 6 in. diameter with 87 fire hydrants, 40 gates, 1 meter and 400 taps. Service pipes are of wrought-iron with lead connections.

The city pays $100 yearly for each hydrant. The population in 1880 was 6,668, it is now said to be 12,000. The daily consumption in 1883 was 750,000 gallons.

The capital stock of the company is $200,000. The bonded debt is $150,000 at 7 per cent.

The works have cost $203,223, and the receipts have thus far been $13,913. The expenses of maintenance in 1883 were $8,518.

Morgan Jones is President, M. D. Mather Vice President and Wm. Tidball Secretary.

DCLXIII. WINDSOR, N. S.

Windsor, Hants County, Nova Scotia, in lat. 45° N., long. 64 W., is on the Avon River in the vicinity of extensive and valuable quarries of limestone and gypsum. It was incorporated a a town in 1878.

Water-works were built by the town in 1883, after plans of E. H. Keating, C. E., the supply being taken from a brook, the waters of which are impounded by a wooden dam 17 ft. high and 128 ft. long, forming a reservoir covering about 3 acres, and having an elevation of 185 ft. above high tide.

Distribution is by 8 miles of cast-iron pipe of 10 to 4 in. diameter with 44 fire hydrants, 35 gates and 240 taps. Service pipes are of iron and lead.

The population is given as 3,019.

The cost of the works has been $50,000. The bonded debt is $50,000 at 5 per cent. The works are managed by a committee of the Town Council. G. Parker Smith is Superintendent and Fred W. Dimock, Clerk.

DCLXIV. FERGUS FALLS, MINN.

Fergus Falls, Otter Tail County, Minnesota, in lat. 46°-30 W., Long. 96° W. is on rolling prairie land on the Red River of the North. The river has a fall of 200 ft. in 4 miles and furnishes within the city limits an estimated horse power of 15,000.

Settled in 1870, it was incorporated a city in 1881.

Water-works were built by a private company in 1883, after plans of Carroll E. Gray, the supply being taken from the river. A dam of timber and stone is built across the river two miles above the main portion of the city from which the water is brought to the pump house through a circular flume 8 ft. in diameter, under a head of 12 ft., furnishing both the motive power for the pumps, and the supply. It is then pumped by two duplex pumps, driven by a water-wheel, each having a capacity of 1,500,000 gallons, directly into the mains, and giving an ordinary pressure of 55 lbs. which can be increased in case of fire to 100 lbs. A Worthington steam pump of the same capacity is also used as an auxiliary in cases of necessity.

Distribution is by 6 miles of metal-coated, wrought-iron pipe of 12 to 4 in. diameter, with 50 fire hydrants, 30 gates, and 158 taps. All pipes are laid 8 ft. under ground. Service pipes are of so-called indestructible wrought-iron. The city pays $80 yearly for each hydrant. The population in 1880 was 1,635, it is now said to be 6,000.

The works have cost $142,000. The capital stock of the company is $70,000. The bonded debt is $70,000, at 6 per cent. Wm. S. Eaton is President and A. C. Petitt, Superintendent.

WATER.

O WATER-WORKS OFFICIALS.

Croes' Statistical Tables of American Water-Works is the most complete Compendium of Information concerning American Water-works in print. It was published one year ago, and is for the benefit of parties engaged in the Construction, Official Management, or Mechanical Operation of Water-works. If there is any such person, Civil Engineer, Contractor, President, Secretary, Superintendent, or Mechanical Engineer of any Water-works in America, who has use for the book, and who has not got a copy already, we will be pleased to send it to him on receipt of one *five cent postage stamp*, with which to prepay it to his address.

FRANKFORT, KY., is to draw its supply of water from the Kentucky river.

AN artesian well in Greeley, Colorado, has reached a depth of 2,000 ft. The city is now agitating the question of going down to a depth of 2,500 or 3,000 ft. if necessary

JEFFERSON, ILL., is to be supplied with water from the Chicago mains at the rate of 8 cents per thousand gallons.

THE oldest Water company in London, England, is the New River company, which has been in existence 71 years, and has at present 697 miles of 36 in. mains in use.

THE City Water-Works gang of Minneapolis, laid 420 feet of six inch 400 pound pipe, 384 of twenty four one and a half ton pipe, and 240 of thirty inch two ton pipe, in all a total of 1,124 feet in one day recently.

CLEVELAND, O.—The Board of Water-Works trustees has let the contract for constructing the foundation for the Fairmount Street reservoir pumping-station to David Robertson, for $24,705.98.

THE water supplied to the people of Hoboken by the Hackensack Water Co., has been declared unfit for drinking purposes until the reservoir has been cleaned. A temporary supply will be drawn from Jersey City.

A LARGE deep-well pumping engine at the International Health Exhibition, England, has a capacity of 4,500,000 gallons per twenty-four hours, raised from a depth of 200 ft. It was designed by Richard Morland and Son.

STOCKBRIDGE, MASS.—An artesian-well is to be bored near the Stockbridge reservoir, the plan being to have the water run directly into the reservoir. Daniel Dull, who is boring the wells at North Adams, has the contract.

COTTAGE CITY, Mass., July 24.—A preliminary test of the new Water-works was made this afternoon. It was made under some disadvantages, viz.: Unsatisfactory quality of coal, newness of pump and boilers, poor nozzles and a severe gale of wind. Notwithstanding these drawbacks four-inch streams were forced over many of the highest flag poles on the avenue.

NEW WATER-WORKS.—The Richland Water-Works company organized at Belleville, Ill., July 25th, with a capital stock of $150,000, all of which has been subscribed. The stockholders are: J. M. Hay, W. H. Powell, H. A. Kircher, Edward Abend, and John Lorensen, of this city, and Thomas Howard and J. W. Harrison, of St. Louis. Thomas Howard was elected president and J. W. Walker secretary. The work will be what is known as the direct pressure system.

THE Queens County Water-works Company have purchased one acre of land on the easterly side of the Long Island Railroad track at Far Rockaway for the erection of a pumping station to supply Far Rockaway with water. The pumping machinery, which is ready to be put in place, is on the Davidson plan, and will be capable of delivering 1,000,000 gallons of water per day. The stand pipe will be of boiler iron, 100 ft. in height.

THE South Australian Government is obtaining definite information with reference to a scheme propounded by Mr. G. Martin for the conservation of water in the hills in the neighborhood of Gawler, by throwing a large dam across the Para, so as to impound 6,000,000,000 gallons of water. The colonial hydraulic engineer, Mr. Mestayer, the conservator of water, Mr. Jones, and an engineer who has had extensive experience of water conservation works, have paid a visit to the spot at which Mr. Martin suggests the water should be impounded; and the engineer has been set to work to make a thorough examination of the country by boring and otherwise, with a view of ascertaining the holding capacity of the ground, the best place in which to construct the dam, the probable cost, and the quantity of water which may be impounded. The impression seems to be that the scheme is perfectly feasible.—*Engineering.*

NEWS OF THE WEEK.

Railroads and Canals.

THERE are 1,202 miles of railroad in Florida.

THE St. Louis, Iowa and Dakota is a projected road which is fast approaching a reality.

THE electric headlight for locomotives is giving good satisfaction.

THERE were 18668 miles of railway in operation in England at the end of the last year.

THE extension of the C. St. P. M & O. from Woodstock to Pipestone has been completed.

THE Vandalia Company has just finished laying a sixty pound steel rail along its entire line.

So far this year 1519 miles of railroad have been built, compared with 2558 miles in the same time last year and 5100 miles in 1882.

A PARTY of engineers representing the Milwaukee Railroad have begun a survey from Oregon, Ill., toward the Mississippi.

THE permanent survey of the Ultima Thule, Arkadelphia and Mississippi Railroad was commenced July 24th, at Arkadelphia.

THE Philadelphia and Reading road are experimenting with iron sleepers, both cross and longitudinal.

T. APPLETON, a well know Western railroad man telegraphs us: where can I hire a steam shovel for six months, and at what price? Answer at Kansas City, Mo.

THE contract for constructing the Philadelphia and Wilmington division of the Baltimore and Ohio railroad has been let to Messrs. Ryan & McDonald, of Syracuse, N. Y., for $2,000,000.

THE preliminary surveys have been made for a line from Alden, north through Clear Lake and Forest City to Bismark, Dak. It will be a feeder to the Chicago, Iowa and Dakota.

FIFTEEN miles of track have been laid from Lake Park on the Dakota extension of the B. C. R & N. Track laying has commenced at Pipestone on same extension and will proceed towards Watertown.

THE Manitoba and Northwestern will extend its line fifty miles northwest of Minnesota in the Sackatchewan district. Minnesota is the present terminus of the road, and is about one hundred miles northwest of Winnepeg.

THE Southern division of the New Orleans, Louisville and Texas road is now complete, with the exception of the iron bridge across the Homochietto river, which is itself not far from completion.

COSHOCTON, O., June 23.—The engineer corps on the Mount Vernon, Coshocton and Wheeling railroad resumed operations to-day. They will occupy the berme bank of the Ohio canal to Newcomerstown, thence to Wheeling.

WICHITA, KAN., July 22.—The final survey of the Wichita, McPherson and Denver Railroad company is being made from this point to Hutchinson, a distance of 45 miles. The first section of the grade is already let.

THE Mississippi River bridge at Anoka, Minn., will be completed September 1st. There are three spans each 250 ft. long, which, with the draw, will make the bridge about 900 ft. long. It will cost when completed about $70,000.

THE Duluth and Iron Range Railroad was completed through from Agate Bay to the Vermillion mines July 27th, four days ahead of the contract time. The road is sixty-nine miles long and through a fine country and is well built, laid with first quality steel rails and well equipped for its work.

SEVENTY-ONE miles of the middle and western divisions of the L. & St. L. Road has this season been graveled to a depth averaging 15 in. There are but fifteen miles more of road to gravel to complete the work. Twenty-two miles on the Western Division, however, is yet to be ballasted with broken stone.

THE proposed road from St. Paul, Minn., to Mona, Iowa, will be 115 miles in length. It is to be called the Minnesota and Northwestern. Eastern capitalists are furnishing the money. Grading and bridging only will be done this year. Contracts for steel rails have been obtained at $30.50 per ton. The road will be completed next year.

THE Chicago, Burlington and Quincy R. R. has completed five surveys of routes from Platte Summit on the line of the Burlington and Missouri, to points on the Denver and Rio Grande Western; $7,000,000 of new stock has been issued, construction headquarters established at Denver, and contractors asked to bid for the construction of 400 miles of railroad.

HOLLAND has 667 miles of railroad.

A POWHATAN (Ohio) woman gave a warm reception to railroad surveyors who attempted to lay out a line through her yard contrary to her wishes. The first surveyor escaped with his hat riddled with shot from her revolver, while the second man was driven into a mud pond a the point of the pistol, leaving all his tools, which she captured and still holds possession of.

THE first American railway ever built in the Orient, that is, the first railway constructed under the supervision of an American engineer after American models and equipped with American engines, cars and rolling stock, was completed January 21, 1881, on the Island of Yesso, Japan, between Otaro and Sapporo, a distance of 23 miles. It was constructed under the supervision of Joseph Crawford, the well known engineer.

WORK on the extension of the New York, Philadelphia and Norfolk Railroad is being pushed. The projecting line is ninety-four miles long, running down the peninsula, and of this fifty miles below Pocomoke City has been graded. Ballasting is going on in some portions, and track-laying has already been begun and is progressing at the rate of half a mile a day.

ONE of the most important lines ever projected in the South is now under way. It will, when completed, establish an air line from Baltimore to Atlanta, and through its connections to Louisville and St. Louis. The line will be two hundred miles shorter than the Richmond and Danville, or the Virginia and Tennessee line. The track will be laid with 67 pound steel rails.

THE petition for the formation of the Grassy Lake Drainage District, by which 5000 acres in Greene County Ill. will be reclaimed by drainage, has been granted. The following commissioners were appointed :Geo. H. White E. T. Bingham and E. Bridgewater. These men will at once send out a corps of surveyors under Capt. DuBois, who will report the amount of excavation and embankment required. It is estimated that $50,000, or $10 per acre, will complete the work.

A NOVELTY in navigation is a steam catamaran now running on the Hudson upon which four years of experimental work have been expended. She has one central paddle wheel. The dimensions of the strange looking craft are as follows: Length over all, 190 ft.; width on deck, 25 ft.; width of hulls, 5ft 6 in.; draught, loaded, 28 in. There are five watertight bulkheads in each hull, and the entire interior of each is diagonally braced. Her engines are of the type used on Mississippi River steamers, and are made by James Rees, of Pittsburg, Pa. Her two cylinders are 13 in. diameter by 5 ft. stroke. Wheel, 22 ft. diameter, 8 ft. face, 18 in. buckets. Revolutions to be made, 30. She has one high pressure Ward coil boiler, containing 2,500 ft. of coil.

A NEW railroad, independent as yet of any of the systems of that part of the country, has just been surveyed from Dunleith, in the Turtle Mountains, Dakota, to Minnewakan, at the west end of Devil's Lake. The line is designed to reach and form a southern outlet for the coal-fields of the Turtle Mountains, which are large and important, and crop out most heavily along the Willow River, near Dunleith. The new road will be less than 100 miles in length. Mr. Charles F. Peck, of the Mutual Union Telegraph Company, New York, is President, and Col. J. Ledyard Hodge, of Washington, Secretary. Senator Cullom, of Illinois, is one of the incorporators. The right of way has been secured, and actual construction will be commenced at once. The company is called the Dunleith and Southeastern.

CLEVELAND, OHIO, July 27th.—The first electric railroad for public use in America went into operation in this city yesterday in connection with the East Cleveland Street Railroad Company, which has just completed a mile road. The experiment was so successful that the company expects to change its entire system, comprising over 20 miles, into electric roads. The system used was a combination of the Brush and Knight and Bentley systems, and the current was carried on underground conductors laid in conduits like those of cable roads. The cars were started and stopped and reversed with the greatest ease. Any number of cars up to 15 can be run at one time on a single circuit and from one machine, which is a result not attained by any of the European systems now in operation. The success of the new road has made a great sensation in both street railroad and electrical circles, and is expected to greatly extend the field of electrical development, as well as enhance the value of street railroad properties.

THE surveys for the Reading and Pottsville road have been completed.

THE Boston *Advertiser* is authority for the statement that Canadian railroads are built for reasons of national pride, and jealousy of the United States, rather than of commercial requirements. The Intercolonial, the Canadian Pacific and the Short Line, now about to be built in Cape Breton, are quoted in proof of the assertion.

A scheme is also said to be afloat for a railroad from Hudson Bay to Winnipeg. Distance from Winnipeg to Liverpool by this route 3,300 miles; ditto by way of New York, 5,400 miles.

The total number of miles of railroads now in actual operation in the Japanese Empire is estimated at about 260, the most important of which are these:

From Tokio to Yokahama	18 miles.
From Kobe to Otsu	60 miles.
From Nagahama to Sekigahara	10 miles.
From Nagahama to Tsuruga	25 miles.
From Tokio to Tagasaki	75 miles.

All these, save the last mentioned, belong to the Government, and are under the superintendence of the Imperial Railroad Department. There are also fifty-six miles in Hokkaido, in Yezo, and a few miles at the Kamaishi iron works. The earnings of the Tokio and Tagosaki line for the first six months were sufficient to pay an annual dividend of 12½ percent.

Both the government and the company lines are built on the gauge of 3 ft. 6 in., which is the standard gauge of Japan. The road at the Kamaishi Mines is built on a 2 ft. 9 in. gauge. The longest tunnel in Japan pierces Mount Yanagure (Yanagure Yama) between the province of Nagahama and Tsuruga, and is 1,390 yds. in length. The tunnel was cut through on the 16th of November last, after five years' work, and the bricklaying is expected to be finished some time this Summer. The sharpest curve is 20 chains or 1,320 ft. and the heaviest gradient rises 1 ft. in 40. The ties are mostly of chestnut, laid at a distance of 2 ft. 9 in. apart, with the exception of the joints, where they are laid 2 ft. apart. The iron rails, imported from England, weigh 60 pounds a yard, and the steel rails, which at the present time are principally used, weigh 61 pounds a yard. The Tokio and Yokohama line is built of double-headed rails; almost all the rest are flat-bottomed and fish-flutted at the joints.

Miscellaneous.

Two millions of dollars are to be spent in erecting new armories in New York City.

THE estimated cost of the Bennett-Mackay cable is $7,000,000.

A SURVEYING party, consisting of W. O. Johnson, John Eastwood, R. J. Eardon, and F. Bleakely, were drowned in Spanish River, Can.

SAMUEL P. WARREN, Esq., banker, has been elected Treasurer, and H. H. Russel, Right of Way Agent of the U. S. Central Railway Company.

LIEUTENANT D. C. KINGMAN, engineer officer of the Department of the Platte, is engaged in surveying a wagon road from Rawlins to Fort McKinney, Wye.

CIVIL ENGINEER ASSERSON has finished the plans, etc., of the new dry docks which will be recommended to be built at the Norfolk navy-yard. They are to cost $500,000.

WORK on laying the huge iron syphon under the Milwaukee River will be completed in a few days. The syphon is a part of the special sewerage of the city, and is the largest sub merged pipe in the world, being fifty-two inches in diameter.

THE bids for the Hammond street Grammar School House, Boston, were as follows: Hiram Ames, $24,879; Joseph Hammond $24,200; Cressey & Noyes, $21,850; Jerome Hosmer, $21,855; John French $21,172; John Pearson $22,884; P. P. Kelley, $25,777; E. Shapleigh, $21,853. The contract was awarded to Mr. French, the lowest bidder.

THE PENN BRIDGE Co. at Beaver Falls has taken a contract for a highway bridge over the Beaver River, between Rochester and Bridgewater, Mass. The bridge will have one span of 160 feet and two of 200 feet each; there will be two wagon-ways twelve feet wide and a foot walk six feet wide. The contract price is $25,000.

THE trustees of the Lick estate in San Francisco have paid $12,000 to Edmund Feil of Paris for a glass for the Lick observatory on Mount Hamilton, but of nineteen glasses produced all but two have proved defective, and it is not certain that these two will be any better. The glass is to be thirty-six inches in diameter.

THE Welland Canal is to be deepened to 14 ft. of water on the sills.

THE work of reclaiming the Potomac flats along the front of Washington is proceeding satisfactorily, and 120 acres of marsh have already been filled with dredgings from the river bottom. Contrary to expectation these dredgings do not give out malarial effluvia, but are of sand, gravel, and shells. The exhalations from the marshes, which were fomerly very offensive, have ceased. Ultimately a park of 500 acres will be formed along the river front.

GOOD results have been produced at Sandy Hook with the experiments in firing shells containing gelatine from an 8-inch gun. A penetration of seven inches was made, gelatine having a higher explosive power even than dynamite. The experiments are to be continued, and the detonating exploder is to be used, which it is expected will increase the effectiveness of the projectile.

The receipts on the Brooklyn Bridge have fallen about $200 a day this summer, owing to the absence from the city of many ladies accustomed to use the cars in their shopping expeditions to New York. The rain of last Sunday made about $500 difference in the receipts as compared with Sunday before. Only $12 was taken for foot passengers on the Brooklyn side, and only $34 in all was received from those using the promenade.

The bridge receipts now average about $1,300 a day. On Monday last the receipts were $1,406. When the ladies return from the country the dayly receipts, it is expected, will be about $1,500 a day.

BIDS were received by the board of Public Works of St. Louis last week on the following contracts: Three hundred fire plugs—Fulton Iron-works, $17,850; St. Louis Iron and Machine-works, $15,675. Special castings, 30 tons large and 30 tons small—A. H. McNeal, $5,274; Camden Iron-works, $6,990; Shickle, Harrison & Howard, $7,200; and St. Louis Iron and Machine-works, $6,000. Water-pipe, 7,000 tons—Camden Iron-works, Camden, N. J., $214,400; A. H. McNeal, Burlington, N. J., $246,333; Shickle, Harrison & Howard, $211,750, and Cincinnati and Newport Iron Company, $231,700. For laying water-pipe—D. Clifford & Co., $8,750; O'Connell Bros., $11,015.

THE available daily supply of water in Paris is about 100,000,000 galls. for a population of between 2,250,000 and 2,500,000. Between 1876 and 1881 the number of inhabitants rose from 1,988,000 to 2,240,000 at which rate of increase it will be probably 2,500,000 in 1886. The supply of water would then be about forty gallons per head per diem. This is a higher proportion than Londoners obtain, but is far inferior to the supply of Marseilles, which has 180 ga lons a head per day. Although the cesspool system still exists in the city, the Commissioners proposed in 1881 a temporary improvement in the use of metallic cesspools, containing from 60 feet to 200 feet cube, to be emptied by the pressure of the air; but the cost of emptying these weekly would be enormous, irrespective of the expense of providing and fixing a cesspool receptacle. The amount of household and street refuse per day in Paris is 34,000 cubic feet, which is removed by 600 carts. The rate for this expenditure varies from 2 to 14 cents per lineal yard of building frontage, and in 1880 produced $520,000, the whole cost of cleansing being $1,060,000. All houses in Paris are obliged to deliver the rain water and household waste into the sewers, the Municipality providing that every street less than 60 feet wide must have one sewer, and that streets over that width must have one sewer on each side of the way.

PROPOSALS.

Improving Cape Fear River below Wilmington, N. C.

PROPOSALS FOR DREDGING.

U. S. ENGINEER OFFICE, 70 Saratoga Street, BALTIMORE, MD., July 24, 1884.

PROPOSALS for Dredging in Cape Fear River, N. C., will be received until eleven o'clock A.M., August 28, 1884, and opened immediately thereafter.

Blank forms, and specifications can be had upon application to this office.

WM. P. CRAIGHILL, Lt.-Col. of Eng'rs, U. S. Army.

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Improving Cape Fear River below Wilmington, N. C.

Proposals for Furnishing Stone.

U. S. ENGINEER OFFICE, 70 Saratoga Street, BALTIMORE, MD., July 24, 1884.

PROPOSALS for furnishing 30,000 tons of Stone for the improvement of the Cape Fear River, North Carolina, will be received until noon August 28, 1884, and opened immediately thereafter.

Blank forms and specifications, etc., can be had upon application to this office, or to the resident Engineer, Mr. HENRY BACON, at Wilmington, N. C.

WM. P. CRAIGHILL, Lt.-Col. of Eng'rs, U. S. Army.

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